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OF

NEPAL GEOLOGICAL SOCIETY

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NGS NEWS

The 33rd AGM held

The 33rd Annual General Body Meeting (AGM) of the Nepal Geological Society was organized on 23rd Bhadra 2068 (9th September 2011). In that program President of the 14th executive committee Mr. Jagadish Nath Shrestha delivered his speech and highlighted the main functions of his two years tenure. Dr. Dinesh Pathak (General Secretary) and Mr. Dinesh Napit (Treasurer) of the 14th executive committee presented annual report and financial report, respectively. On the same day, a handover ceremony was organized. The president of the 14th executive committee Mr. Jagadish Nath Shrestha handed the key of the Nepal Geological Society to Mr. Uttam Bol Shrestha, President of the 15th Executive committee in the presence of chief guest Mr. Shankar Koirala, Secretary of the Ministry of Industry. Mr. Uttam Bol Shrestha, newly elected president of the Nepal Geological Society delivered his speech mentioning the programs which he and his team want to do in his tenure. Chief Guest, Mr. Shankar Koirala congratulated the newly elected president and wished for his successful tenure. During the discussion among the members, Mr. Krishna Prasad Kaphle, Mr. Churna Oli, Mr. Sagar Rai and Mr. Diwakar Khadka raised different issues of the Nepal Geological Society such as publications, activity of the society, job creating opportunity etc. Newly elected President, Mr. Uttam Bol Shrestha assured the members to think on these issues. Speeches by different persons during the 33rd AGM are given in pages 3-19.

Committees of NGS formed

15th Executive committee of the Nepal Geological society has appointed coordinator and members of different committees. Mr. Sarbajeet Prasad Mahato has been appointed as the coordinator of the Land and building management sub-committee. Mr. Krishna Prasad Kaphle has been appointed as the coordinator of the Public relation and financial committee. Similarly, Mr. Acutananda Bhandary, Prof. Dr. Vishnu Dongol, Mr. Jagadish Nath Shrestha and Mr. Siddhi Pratap Khan have been appointed as the coordinator of the Rules and regulation committee, Scientific committee, Standard committee and IDDR committee, respectively. Dr. Lalu Prasad Paudel has been appointed as the chief editor of the Nepal Geological Society. The member of committes of the NGS are given in pages 20-25.

IDDR Day-2011 observed

In order to observe **the International day for disaster reduction (IDDR) day-2011**, Nepal Geological Society organized one day workshop in association with Mitra Kunj and Russian Center of science and culture on 19 October, 2011. This program was supported by Kathmandu Metropolitan City (KMC). The workshop was held in the Russian Centre of Science and Culture, Mitra Kunja, Kathmandu, Nepal. NGS had requested school children, university students, geoscientists and senior officials of ministries and departments of the Government of Nepal to participate in the workshop. There were more than 130 participants in the workshop. The workshop was organized into two sessions. The first session was inaugural session and the second was technical session. The technical session was divided into two sessions before and after the lunch. Mr. Shankar Prasad Koirala, Secretary, Ministry of industry inaugurated the program. Mr. Koirala stressed on the need of initiation from geoscientists for disaster reduction in a Himalayan country like Nepal. Acting director of Nepal Bal Sangathan, Mr. Ramesh Bhomi expressed his views over the program and enlightened possible collaboration with NGS on disaster prevention and awareness. There were six technical presentations on natural disaster and their mitigation. Mr. U. B. Shrestha, President of Nepal Geological Society welcomed the participants. The inaugural program was addressed by Mr. S. P. Mahato, Department of Mines and Geology and finally Mr. S. Rajaure, General Secretary of the society paid vote of thanks.

In the technical sesson four scientific papers were presented by experts. Please see 27-36 pages for further information about the ISDR-Day 2011.

Scientific talk programmes organized

The Scientific committee of the Nepal Geological Society organized four scientific talk programmes to the scientific community of the Nepal Geological Society. Dr. Yokito Sugimura, Japan Water Agency (JWA) gave a scientific talk on "***New Findings of the Kathmandu Groundwater Basin in Nepal***". Dr. Kyle Larson from the University of Saskatchewan, Canada gave presentation on "***Fingerprinting Himalayan Convergence Accommodation Processes***". Dr. Gyanendra Gurung from the Chonbuk National University Graduate School, South Korea talked on "***Theoretical Seismograms for 3-D Heterogeneous Models with Variable Surface Curvatures: Torsional Modes***". Mrs. Pramila Shrestha of Department of Irrigation, Nepal gave presentation on "***Present scenario of morphological development of the Bagmati River, Kathmandu Basin, Lesser Himalaya***". The abstracts of these scientific talks are given in pages 37-40 of this Bulletin.

27th HKT Orgnanizing Committee and Sub-Committes formed

Nepal Geological Society is hosting the 27th Himalaya-Karakoram-Tibet (HKT) Workshop in Kathmandu, Nepal, during November 28-30, 2012. For the successful organization of the Workshop, present executive committee of the NGS has formed organizing committees and sub-committees. First and second circulars of the 27th HKT has been already distributed to national and international communities. Please see more elaborated news on HKT in page 41-46.

33rd ANNUAL GENERAL BODY MEETING OF THE NEPAL GEOLOGICAL SOCIETY

नेपाल भौगर्भिक समाजको ३३ औं साधारण सभा

Speech by Mr. Jagadish N. Shrestha, President of NGS,
delivered to the 33rd Annual General Body Meeting
23rd Bhadra 2068 (09th Sept. 2011)

नेपाल भौगर्भिक समाजका संम्मानित सदस्यहरू
भूतपुर्व अध्यक्षज्यूहरू
सदस्य साथीहरू
महिला तथा सज्जनवृन्द

नमस्कार,

सर्वप्रथम म यस ३३औ वार्षिक साधारण सभामा उपस्थित हुनुभएका सम्पूर्ण अतिथी महानुभावहरूमा एबं सदस्य साथीहरूमा १४ औं कार्यकारिणी तथा मेरो आफ्नै तर्फबाट स्वागत अभिनन्दन गर्दछु । बिश्वासका साथ निर्बिरोध निर्बाचन गरी २ वर्ष समाजको सेवा गर्ने अबसर प्रदान गर्नु भएकोमा समाजका सम्पूर्ण सदस्य साथीहरूलाई धन्यबाद ज्ञापन गर्न चाहन्छु ।

२ वर्ष अघि जुन घडी नेपाल भौगर्भिक समाजको १३ औ कार्यकारिणी समितीले आफ्नो जिम्मेवारी १४ औ कार्यकारिणी समितीका म र मेरो टोलीका साथीहरूलाई हस्तान्तरण गऱ्यो त्यस घडि देखी म र मेरो साथीहरूको काँधमा रहेको समाजका सम्पूर्ण काम कारवाही सफलतापूर्वक सम्पन्न गरी अहिले १५ औं कार्यकारिणी मा हस्तान्तरण भई समाजलाई अगाडी बढाउने गहन जिम्मेवारी आईपुगेको छ । साथीहरू मलाई विस्वास छ, सबै सदस्यहरूले यो जिम्मेवारीको गहनतालाई बुझनुभएको छ र आफनो बलबुता र सामर्थ्यले भ्याएसम्म यो जिम्मेवारी सफलताका साथ पुरा गर्नुहुने छ । यस अबसरमा नवनिर्वाचित अध्यक्ष श्री उत्तमबोल श्रेष्ठ ,जो पुरानो परीचित साथी हुनहुन्छ र उहाँको टिमले समाजलाई अरू नयाँ उचाईमा पुऱ्याउनेछ हुनेछ भन्नेमा म विश्वस्त छु ।

नेपालमा विभिन्न पेशागत समाजहरू मध्य हामी नेपाल भौगलिक समाजको एक छुट्टै उच्च स्थान रहेको छ । गत ३० वर्षको अवधीमा यस समाजले विशिष्ट पेशागत अवधारणा भित्र रही आफ्नो उद्धेश्य अनुरूप भौगभिक ज्ञानको विकास तथा भूगर्भविद, भू-प्राविधिकहरूको कल्याणको लागी काम गदै आईरहेको छ । गत ३० वर्ष देखी निरन्तर रूपमा प्रकाशीत भु वैज्ञानिक जर्नल , वुलेटिन, सम्पन्न कयौं राष्ट्रिय तथा अन्तराष्ट्रिय कंग्रेस, सम्मेलन आयोजना, भू-वैज्ञानिक संम्मान तथा उत्थानको लागी भनेको कार्य गरि हाम्रो समाजले नेपालको वैज्ञानिक समाजका बिच आफ्नो ठाँउ बनाएको छ । १४औ कार्यकारिणीले यि सबै कार्यहरूलाई गत दुई वर्ष सम्म निरन्तरता नै दिईआएको छ ।

यस उपलक्ष्यमा म समाजको गत दुई वर्षको कार्य संपादन बारे छोटो जानकारी गराउन चाहन्छु ।यस अबधिमा मुख्य कार्य भनेको नेपाल भौगर्भिक समाज को छैठौ काग्रेसको आयोजना रह्यो । नवेम्बर १५ देखि १७, २०१० सम्म ३ दिन चलेको यस काँग्रेसमा २५ दैशका १०० भन्दा बढि विदेशी सहित करिब ३०० भूगर्भबिदहरूको सहभागीता रह्यो । सत्र रहेको यस काँग्रेसमा स्वदेशी विदेशी भूगर्भबिदहरू वैज्ञानिक लेख तथा अनुसन्धान सम्बन्धित लेख रचनाहरू प्रस्तुत तथा छलफल गरिए ।

उक्त काँग्रेसको एक प्रमुख कुरा काँग्रेसको उद्धघाटन नेपालका प्रथम राष्ट्रपति संम्माननिय डा. रामवरण यादव ज्यू वाट हुनु रह्यो ।

संमाननिय राष्ट्रपति वाट भएको गरिमामय सेवापनले राष्ट्रले भूगर्वज्ञान तथा भूगर्वबिदहरू लाई दिएको महत्वलाई झल्काउछ भन्ने लाग्छ । हामी राष्ट्रको वैज्ञनिक मन्चमा आईपुगेका छौ र अव राष्ट्रले हामी प्रति र हामीले राष्ट्रप्रति केहि अपेक्षाहरू राख्ने वेला आएको छ ।

आफ्नो कार्य ब्यस्तताको वावजुत काँग्रेसको उद्धघाटन गरी भूगर्बविदहरू बिच केहि घण्टा समय बिताई बिचार आदान प्रदान गर्नु भएकोमा संम्माननिय राष्ट्रपति डा. रामवरण यादव ज्यू प्रति सम्पूर्ण समाजको तर्फ बाट हार्दिक धन्यबाद कृतज्ञता ज्ञापन गर्न चाहन्छ ।

यसै अवसरमा म, काँग्रेसको सफल आयोजना गर्न मरीमेटी लाग्ने कन्भेनर श्री कृष्ण प्रसाद काफले, बिभीन्न समितीमा रहि कार्य गर्नु हने सम्पूर्ण सदस्य साथीहरू, आर्थिक , लजीस्टिक सहयोग प्रदान गर्नु हुने सरकारी, गैरसरकारी निकाय एवं व्यक्तिहरू प्रति समाज तथा १४ औ कार्यकारिणी र आफनै व्यक्तिगत रूपमा हार्दिक धन्यवाद दिन चाहन्छु ।

यस काँग्रेस वाहेक गत दुई वर्षमा विभिन्न लेक्चरहरू Talk programme, ISDR Day मनाउने, जर्नल एवं बुलेटिन प्रकाशन गर्ने कार्यको निरन्नतरतानै रह्यो ।

समाजको क्रियाकलाप स्थापना कालको तुलनामा गत वर्षहरूमा निकैनै बढी भैसकोको छ । ६०० भन्दा बढी सदस्यहरू लाई चिठी पत्र टेलिफोन वा मुखको भरले सूचना आदान प्रदान गर्न सहज छैन । न त स्वयं सेबक रूपमा काम गर्ने समाजका पदाधिकारीहरूले हरेक सुचना हरेक सदस्यकहाँ हरेक सुचना पठाउने ग्यारन्टी नै गर्न सक्दछ । तर सुचना पुऱ्याउन पनि जरुरी छ । Internet Highway को जमानामा समाजले पनि अत्याधुनिक प्रबिधी अपनाउनु पनि जरुरी छ र संभब पनि छ । तसर्थ, अब समाजको Web site लाई सबैले सजिलै आफै पहुच गर्न सक्ने बनाउन यथा संभब कोशिस गरीयो र समाजका सबै सुचनाहरू Internet मार्फत प्रसारित गरीएका छन् । त्यस वाहेक समाजका Web site मा समाज सम्बन्धी बिभीन्न सुचनाहरू, जर्नलहरू, विभिन्न लेखहरू, नैपाल भूगर्ग सम्बन्धी समाजका सम्मानित सदस्य वाट लेखिएका लेखहरू वहाँहरूका जिबनीहरूआदी पनि राखी अध्याबधि गरिएको छ । यो सबै वृहत कार्य गर्नु भएकोमा संबन्धित समितीका संयोजक डा. श्री रञ्जन दाहाल र उहाँको टिमलाई धन्यवाद छ ।

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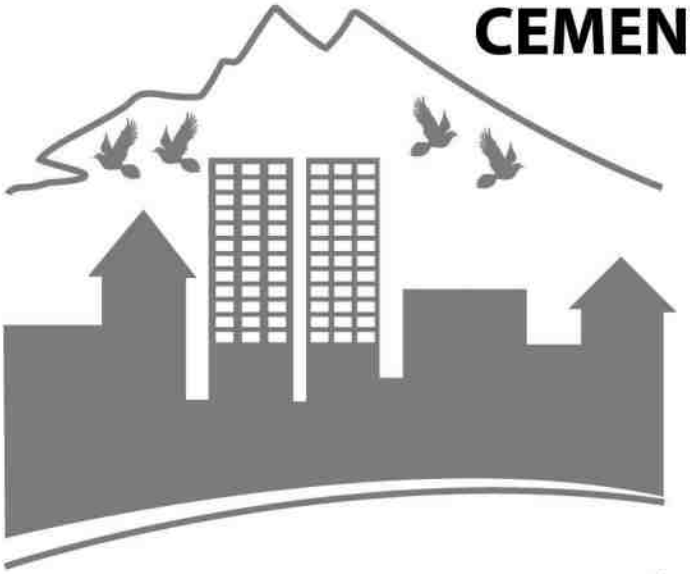

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समाजको आफनो स्थाई स्थान नहुँदा अत्यन्त कठीन भैरहेको हामी सबैले महशुस गरेकै छौ । नेपाल सरकारले विभिन्न पेशागत समुह जस्तै इन्जिनीयरिड. एसोसिएसन, बार एसोसिएसन, रेन्जर समाज, आदिलाई उपलब्ध गराए जस्तै सानो टुक्रा जग्गा उपलब्ध गराउन नेपाल सरकारलाई आग्रह गरिएको थियो । यसको लागी उद्योग मन्त्रालयको सचिबबाट आश्वासन पाए पनि कार्यान्वयन हुन सकको छैन ।

यस अवधिमा समाजले स्वदेशी तथा बिदेशी भौगर्भिक ज्ञानमा कार्यरत संघ सस्थाहरू संग संम्बन्ध बिस्तार गर्ने कार्य जारी राखियो । यसै क्रममा Geological Society of America (GSA) संग वृहत छलफल भएपछि GSA ले नेपाल भौगर्भिक समाज लाई GSA को Associate Membership प्रदान गरेको छ । विश्वका अन्य राष्ट्रका नगन्य मात्र भौगर्भिक सस्थाहरू लाई प्रदान गरिएको उक्त सदस्यताबाट हाम्रो समाजको बिश्वमा बढदै गएको ब्यापकता र पहिचानको प्रमाण हो भन्ने मलाई लाग्दछ । यसबाट GSA र नेपाल भौगर्भिक समाज बिच सस्थागत रूपमा सुचना तथा भेटघाटहरू आदान प्रदान हुनेछ ।

समाज को बढ्दो अन्तरराष्ट्रिय ईज्जत स्वरूप आउदो साल २०१२ को हिमालय काराकोरम टिबेट कार्यशाला HKT Workshop गर्ने जिम्मेवारी पाएको सुनाउन पाउँदा खुसी लागेको छ । हाम्रो अनुभवको आधारमा नवेम्बर २०१२ मा उक्त HKT २०१२ सफलता पूर्वक संम्पन्न हुनेमा म बिश्वस्त छु ।

३१ बर्ष अगाडी स्थापित हाम्रो समाजको कार्य क्षेत्र आज आएर निकै ब्यापक र गहन भएको छ । यसले गर्दा आज समाजको दैनिक कार्य संचालन, पत्राचार आदि गर्नु निर्वाचित पदाधिकारीले गर्दै आएको स्वयंसेबिको कार्यले मात्र निकै गाह्रो अनभब भएको छ । यसैले मेरो बिचारमा समाजको अध्यक्ष , महाँसचिब र कोषध्यक्ष लाई मद्दत गर्न एक स्थाई सँचिबालय को ब्यबस्था गर्नु जरुरी भएको ठान्दछु ।

त्यस्तै आज नेपाली भूगर्भबिदहरूको कर्म क्षेत्र विस्तार हुनाले भूगर्भशास्त्रको विभिन्न पक्षमा आधारीत भएर Paleontology, GIS, Geotechnics तथा Landslide संग संम्बन्धित समाजहरू स्थापना भएकाछन् । यो भूगर्भ ज्ञानको बिकासको क्रममा हरेक देशमा हुने प्रक्रियानै हो र यस लाई रोक्नुको औचित्य पनि छैन । तर हाम्रो समाज यस्ता सबै समाजका सदस्य रहेको भूगर्भविद् साथीहरूको छाता संगठन भएको नाताले , हाम्रो समाजको बिधानमा भूगर्भ संग सम्बन्धीत संगठित सस्था कंम्पनीहरू लाई पनि सदस्यता कायम गरी सबै लाई समाहीत गर्न Associated Member को ब्यबस्था गर्नु आवश्यक भएको ठान्दछु ।

२ वर्ष अगाडि हामीले पदभार ग्रहण गर्दा केहि कार्य योजना अगाडी सारेका थियौ । ती मध्ये कतिपय पुरा भए भने कतिपय बिभीन्न कारणवस पुरा गर्न सकिएन । तर पनि मेरो अनभव सुखद रह्यो । आफनो पेशागत जिन्दगीमा यी दुई वर्ष समष्टिगत रूपमा सम्झन लायक भयो । मैले राष्ट्रपती कार्यलय देखी सरकारका विभिन्न मन्त्रालय र बिभागहरू, सरकारी गैर सरकारी निकायहरू, प्राईभेट सेक्टरका ब्यापारी, शैक्षिक सस्थानहरू , ब्यक्तिहरू र समाजका साथीहरूबाट पाएको हार्दिक सहयोग सदभावना नै समाज प्रती रहेको सदभावना कै प्रतिक हो भन्ने ठानेको छु र त्यसको लागी म १४ औं कार्यकारी समिती र आफनो तर्फबाट हार्दिक धन्यबाद दिन चाहन्छु ।

यस अवसरमा यस समाजलाई स्थापनाकाल देखि प्राविधिक, भौतिक र आर्थिक सहयोग गर्दै आउनु भएका सम्पूर्ण सरकारी गैर सरकारी निकायहरू , कन्सलटेन्सीहरू खनिज तथा खनिजमा आधारित उद्योगहरू र अन्य उद्योगी व्यवसायी संघ संगठन साथीहरूलाई हार्दिक धन्यवाद ज्ञापन गर्दछु। अन्तमा १४ औं कार्यकारिणीको अध्यक्षको रूपमा समाजको सेवा गर्ने मौका दिनुभएकोमा सबै साथीहरूलाई हार्दिक धन्यबाद ज्ञापन गर्दै आफ्नो भनाई यहि पूरा गर्दछु र बिदा लिन्छु ।

धन्यबाद !

Best wishes for the grand success of

An International Conference on the Geology of Himalaya-Karakoram-Tibet Region

27th Himalaya-Karakoram-Tibet (HKT) Workshop

28th – 30th November 2012

Kathmandu, Nepal

to be organized by

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33rd ANNUAL GENERAL BODY MEETING OF THE NEPAL GEOLOGICAL SOCIETY

नेपाल भौगर्भिक समाजको ३३ औं साधारण सभा

Annual Report by Dr. Dinesh Pathak, General Secretary, NGS, delivered to the 33rd Annual General Body Meeting

23rd Bhadra 2068 (09th Sept. 2011)

Respected Chairman
Respected Honorary Members of the Society
Respected Past Presidents
Distinguished Fellow Members
Ladies and Gentlemen

It is a great pleasure for me to welcome you all on behalf of the 14th Executive Committee of the Nepal Geological Society in the 33rd AGM of the Society. It looks yesterday that we had taken the NGS Executive Office but two years has already passed. In last two years, we gave prime importance to the NGS activities. Instead of making commitment, we sincerely worked on various aspects that were necessary to further uplift the NGS status as a dynamic professional society. We put all our efforts for the optimum achievement of the objectives of the Society. I will briefly present below the work that we carried out during the last year (2068 BS) of our tenure and the areas in which we were not able to work strongly.

Restructuring the website of Nepal Geological Society

After building up the email database of the NGS members, we focused on the restructuring activity of the website, which is an important aspect to disseminate our professional activities to the members, general public and to the international community.

The website of Nepal Geological Society has been completely restructured with new look. We have uploaded more than 75% abstracts of all our publications since 1980, uploaded the bulletins of the Nepal Geological Society. However, it is a huge task and we have not been able to prepare and upload entire publication yet. I hope the coming EC will accomplish this task

The web site has been envisioned with a platform to provide information on Himalayan Geology. For this we requested to our Honorary Members and Senior Members of the Society to contribute on various aspects. Till date, 4 articles have been uploaded in this page and we hope some more will be added in the coming days.

There is provision for Online application for membership, contributors can submit articles online for the publication in NGS Journal and one can provide suggestions to NGS through the website. Almost all activities of the 14th EC have been uploaded on the website so that it will work as an online documentation centre in future if given continuation in the coming days. We have reported each and every activities of the EC to all members and concerned community/ organization, responded them immediately on their queries.

Celebration of ISDR Day

ISDR Day 2010 was observed with the theme **"Making Cities Resilient: My City is Getting Ready".** Around 125 participants were present from various sectors including government and non-government organization, UNDP, UN-OCHA and media. Five technical papers were presented in the technical session. The Chief Guest was Mr. A. R. Pokharel, Secretary, Government of Nepal/Executive Officer, Kathmandu Metropolitan City. The program was supported by Kathmandu Metropolitan City and Lalitpur Sub-Metropolitan City. We consider this approach towards building partnership with the local authorities in our activities.

The ISDR report was prepared and uploaded in the NGS website. We received positive response from many organizations. Dr. Jaya Kumar Gurung and his team contributed for the successful organization of the events.

Organization of Sixth Nepal Geological Congress

Sixth Nepal Geological Congress on "Geology, Natural Resources, Infrastructures, Climate Change and Natural Disasters" has been successfully organized. The Chief Guest, Rt. Honorable President of Nepal, Dr. Ram Baran Yadav inaugurated the 6th Nepal Geological Congress on 15 November 2010. Three days long Congress was attended by over 100 foreign participants from 23 countries and about 125 participants from Nepal. Total of 169 abstracts of the research papers are published in the Abstract Volume as Special Issue of the Journal of Nepal Geological Society volume 41. Alltogether 5 keynote papers, 6 Special papers, 78 General papers and 24 Posters were presented by distinguished participants in three parallel, 15 Technical Sessions.

During Inaugural Ceremony Nepal Geological Society has awarded Honorary Fellow Membership of Nepal Geological Society to four distinguished geoscientists Dr. G. Fuchs (Austria), Dr. K. Arita (Japan), Prof. Dr. M. P. Sharma (Nepal) and Mr. J. M. Tater (Nepal) who had contributed significantly in the research and development of the Geology of Nepal Himalaya. The Chief Guest was very kind to distribute the Honorary Fellow Membership to them.

We consider that the very successful organization of the Congress with overwhelming participation from various countries has further elevated the NGS image as a professional society. We have received many compliments from around the world. In addition, we utilized this congress as an opportunity to raise the fund for the Society.

Cairn Energy, Embassy of India, DASE France, CalTech, ICIMOD, Phool Kumari Mahato Trust, several organizations from Nepalese mining and other industry sectors provided financial support for the NGC-VI. The credit to the success of this Congress goes to you all and we are especially thankful to Mr. S. P. Mahato, Director General, Mr. Sri Ram Maharjan and Mr. S. N. Sapkota, DMG; Mr. B. M. Jnawaly from Cairn Energy for their key role in fund raising for the Congress. Likewise, Prof. B. N. Upreti, Dr. S. M. Rai, Dr. R. M. Tuladhar, Mr. U. B. Pradhananga and Mr. S. R. Sharma had played crucial role, especially in the Post Congress Field Excursion. Nevertheless, Mr. K. P. Kaphle was at the focal point taking the responsibility as Convener of the Congress. His hard work was vital to the success of the Congress.

Communication with various organizations

Concerned Government and international agencies were constantly communicated. A smooth relationship has been established/re-established with them, especially with the UNDP, SAARC Secretariat, Ministry of Home, Ministry of Environment, Ministry of Industry and Ministry of Science and Technology.

NGS has associated with the Geological Society of America. This is another milestone towards getting international accreditation. We have to make full utilization of this association in coming days for the benefit of the Society.

Creating job opportunity

We gave continuation towards our effort to create more position in the government organization. We had met the then Minister, Ministry of Science and Technology and advocated the need of geoscientist in the Ministry and he was convinced but the frequent change of the Ministers was the obstacle for delivering the message within the ministry. Recently, we had meeting with the Secretary of "Ministry of General Administration" and requested him to create positions at those organizations where Geological Expertise is required (like DoR) and to increase the positions in other organizations. Mr. Secretary kindly listened to us, reiterated the importance of geosciences in development projects and assured us to take necessary steps. We believe that continuous effort is necessary to get satisfactory result and approach should be made from every corner. This is the area that we have not been able to achieve countable success.

Organization of scientific talk program

Two Scientific talk programs were organized during the last year and total of three presentations were made in the presence of a good number of audience from government, academic and private sector. Dr. Vishnu Dangol, Coordinator of the Scientific Sub-Committee played active role in the organization of the program.

Organization of HKT workshop in 2012

We have made approach to organize the HKT Workshop after a long gap in 2012. We also sent a request letter during 25th HKT in USA (Prof. Dr. B. N. Upreti and Mr. S. N. Sapkota had participated in the workshop and advocated on behalf of the Society). During the series of communication with the international community, we made approach to the organizer of the 26th HKT in Canada and sent a presentation with history of NGS, organization of national and international conference etc. The organizer presented on behalf of NGS and finally we were granted the opportunity to organize the 27th HKT in 2012. This is another achievement for NGS that proves the trust of international community in our capacity to organize an international event after 1999.

Once we received the information, we initiated the preparatory work. We have setup space for HKT 2012 in our website, received the email addresses of potential participants, requested the organizer of the 26th HKT to disseminate this information world-wide and put link to our website has been put in their site. A meeting was held with the presence of Presidents, General Secretary and Treasurers of 14th and 15th EC together with some of the past presidents and vice-presidents of NGS. It had decided to request Dr. D. R. Kansakar to work as Convener of the workshop. With his kind consent, a small working team of Convener, presidents of 14th and 15th EC has been formed to initiate the work.

Publication

During the last two years, two bulletins (v. 27 & 28), 3 journal issues (v. 39-41) have been published. Volume 42 (to be published in June 2011) is at final stage; many articles of the proceeding volume (volume 43) have been reviewed and this volume is expected to be published by December 2011. Dr. Santa Man Rai and his editorial team is putting it's full effort to publish these issues in time.

The French version of the Himalaya-Tibet Collision book has already been published with the Nepal Geological Society as co-publisher. Soon we will receive the translated manuscript to publish Nepal Geological Society as principal publisher and French Geological Society as co-publisher. I hope the coming executive committee will pay attention to accomplish this job.

Land and building of the society

We had approached the government authority to provide land for NGS building construction. Initially, the land allocation to societies was withheld by Ministerial level decision so the process could not move ahead. Recently, government has given lands to some societies so initiation has again taken to achieve the land. In this context a meeting was held with

the Secretary of the Ministry of Industry to request a piece of land within the compound of DMG. The Secretary gave a favorable response and official request had already been made. Let us hope a definite positive result will come out in near future.

Election of 15th executive committee

An Election Committee was formed under the Chairmanship of Mr. Gyani Raja Chitrakar to hold election of the 15th Executive Committee. The information of the election was disseminated to the members from various means and media. All the candidates in the seven positions except for the Joint-Secretary position were unanimously elected. The election was held on 2068/05/09 for joint secretary. I would like to extend sincere thanks to the Election Committee for their great support and congratulate the 15th EC team wishing their success in further uplifting the Society.

Other activities

Renewal of the Society with the District Administration Office and District Development Committee, Kathmandu and correspondence with different organizations were some of the other regular activities of the Society. During the last two years, around 50 new members have joined NGS at various categories.

Performance evaluation of 14th EC

For the first time in the history of Nepal Geological Society, we have initiated to evaluate the performance of the Executive Committee openly. It has been done through email correspondence as well as through the NGS website, which provided us an opportunity to hear from those members who are not able to present and express their views in the AGM. This is aimed to make the Executive Committee more responsible. We believe that the compliments and suggestion received will be an energetic factor for EC to further actively work in the betterment of the Society.

We received only few responses through email till August 31st and I have no information regarding the mail received afterwards as I have not received any forwarded mail from present executive committee. Likewise, around 34 members have participated in online evaluation that consisted of structured and open questionnaire. The responses received so far is as below (you can see the result online on NGS website):

Six members expressed in written. They were in favor of this type of survey and wished to be continued in future too. Some of the members expressed their concern towards the less efforts paid by the EC towards the welfare of the members, especially towards creating job opportunity. The result of the structured questionnaire is tabulated below:

SN	Question	Excellent	Good	Fair	Not bad	Worse
1	Information dissemination and Interaction with members	64.25%	25.8%	9.7%	0	0
2	Information on the website	75%	18.8%	3.1%	0	3.1%
3	Establishment of the relationship with national and international organizations	68.8%	21.9%	9.4%	0	0
4	Organization of NGC-VI, ISDR Day, Scientific talk program	73.3%	23.3%	3.3%	0	0
5	Whether the 14th EC has been able to contribute to the upliftment of the overall status of NGS	62.5%	31.3%	3.1%	0	3.1%
6	Your over all general evaluation of the workings of the 14th Executive Committee	60%	36.7%	0	0	3.3%
7	As member, have you ever contributed to the activities of NGS	Yes, time to time - 55.9%; Yes, sometime, not frequent. - 23.5%; Yes, once a year. - 2.9%; No, I live in out of Kathmandu. - 14.7%; No, I am not interested to NGS. - 2.9%				

In addition to the above, we have received complimentary mails from our honorary members (e.g. Patrick LeFort and JM Tater) and other Members. Mr. Rajaure, General Secretary of 15th EC informed me that many such mails has also been received in NGS mailing address also after Sept 1st (the day I handed over the responsibility to newly elected Gen. Secretary).

Dear Members, the above mentioned activities of the present executive committee has been materialized only with your support and constructive advice. We would like to thank you for your co-operation, support and advice.

We are happy to hand over the well tracked, fully streamlined NGS towards achieving the goals and objectives as envisioned by the constitution of the Society. I believe the 15th EC will stand on this platform and further elevate the status of NGS.

Thank you all.

President, 14th Executive Committee, Nepal Geological Society,

Respected Chief Guest, Mr. Shankar Koirala, Secretary,

33rd ANNUAL GENERAL BODY MEETING OF THE NEPAL GEOLOGICAL SOCIETY

नेपाल भौगर्भिक समाजको ३३ औं साधारण सभा

Annual Financial Report by Mr. Dinesh Napit, Treasurer, NGS, delivered to the 33rd Annual General Body Meeting 23rd Bhadra 2068 (09th Sept. 2011)

यस सभाका सभापति तथा समाजका अध्यक्ष ज्यू
वर्तमान कार्यकारिणीका साथीहरू एवं
समाजका सम्पूर्ण सदस्यज्यू,

यस १४ औं कार्यकारिणी समितिको २ बर्षे कार्यकालको अन्तिम वर्ष गत आ. व. २०६७६८ को एक वर्षको अवधिमा भएको यस समाजको आर्थिक विवरणलाई यस वार्षिक साधारण सभा मार्फत तपाईंहरू समक्ष प्रस्तुत गर्न पाउँदा खुसी लागेको छ । तपाईंहरूकै निरन्तर सक्रियता, सहयोग र सदभावबाट यस समाजले आफ्नो आर्थिक स्रोत जुटाउन र यसका विभिन्न क्रियाकलापहरू सफलतापूर्बक संचालन गरि आफ्नो गरिमा कायम राख्न सफल भएको छ । यसै सन्दर्भमा यस समाजप्रति आर्थिक सहयोग पुऱ्याउनु हुने सम्पूर्ण व्यक्ति तथा संस्था प्रति आभार र धन्यवाद ब्यक्त गर्न चाहन्छु ।

अव म गत आ. व. को आर्थिक विवरण प्रस्तुत गर्न चाहन्छु । सर्व प्रथम गत आ. व. को खर्च र आम्दानीको संक्षिप्त विवरण पेश गर्न चाहन्छु ।

गत आ. व. मा जम्मा रू. ३९,६७,४६६ आम्दानी भएको छ । यसको मुख्य श्रोतको रूपमा आर्थिक सहयोगबाट रू. ३१,४७,२५१, रजिष्ट्रेशन शुल्कबाट रू. ३,५७,३९९.५०, जर्नल बिक्रीबाट रू. ३८,२५०, सदस्यता शुल्कबाट रू. ८,५००, ब्याजबाट रु ६१,२८५ र अन्यबाट रू. ३,५४,७५० भएको देखिन्छ। त्यसैगरी खर्च तर्फ मूख्यतः Sixth Geological Congress सहित सेमिनार खर्च रू. २७,९२,४३४, छपाई खर्च रू. २,४८,१०८ र अन्य गरी जम्मा रू. ३२,९६,५८० खर्च भएको छ ।

यसरी खर्च भन्दा आम्दानी बढि हुन गई रू. ६,७०,८५७ बचत भएको छ। हाल समाजसँग विभिन्न बैंकहरूमा रहेको नगद मौज्दात, पेश्की, वक्यौंता गरी अन्तिम नगद मौज्दात रू. २९,७९,०३३ र पैसा ३३ मात्र रहेको छ । यस कार्यकारिणी समितिले आफ्नो कार्यभार सम्हाल्दा अमेरिकी डलर को मौज्दात USD २३,६११/१ रहेकोमा हाल सो रकम करिव १००० डलरले बढ्न गई जम्मा USD २४,४२९।९४ मौज्दात रहेको छ । तर पनि अमेरिकी डलरको नेपाली रूपैयाँसँगको परिवर्तिय दर (exchange rate) तत्कालीन अवस्थामा USD १ बराबर रू. ७९.०५ रहेकोमा हाल असार मसान्तमा सो दर घट्न गई रू. ७०.९५ गत आ.व. मा रू. ९८,५२० घाटा हुन गएको देखिन्छ। यति हुँदाहुँदै पनि समग्रमा हामीले कार्यभार सम्हाल्दा यस समाजको जम्मा नगद मौज्दात २४,४९,४५५ रहेकोमा त्यसमा रू. ५,२९,५७८ थपिन गई अन्तिम मौज्दात रू. २९,७९,०३३ रहन गएको छ ।

अन्त्यमा यो आर्थिक प्रतिवेदनको विवरण सम्बन्धि कुनै प्रतिक्रिया र सुझावहरू भए सोको अपेक्षा राख्दै मेरो प्रस्तुति अन्त्य गर्दछु ।

धन्यवाद

दिनेश कुमार नापित
कोषाध्यक्ष
१४ औं कार्यकारिणी समिति
नेपाल भौगर्भिक समाज

33rd ANNUAL GENERAL BODY MEETING OF THE NEPAL GEOLOGICAL SOCIETY

नेपाल भौगर्भिक समाजको ३३ औं साधारण सभा

Speech by Mr. Uttam Bol Shrestha, President-elect, NGS, delivered to the 33rd Annual General Body Meeting 23rd Bhadra 2068 (09th Sept. 2011)

Ministry of Industry,
Director General, Mr. S. P. Mahato, Department of Mines and Geology,
Respected Honorary Members of the society
Distinguished officials of Government of Nepal,
Representatives from different industries and organizations,
Ex-presidents and Fellow members of Nepal geological Society,
Media personnel
Ladies and Gentlemen,

On behalf of the newly elected 15th executive committee and as a newly elected president of the Nepal Geological Society, I take this privilege to welcome all of you in this gathering on the occasion of the biennial evening of 33rd general body meeting and handover ceremony of Nepal Geological Society. We would like to express our sincere gratitude and hearty thanks to all of you for being with us in this evening.

Let me take this opportunity to express our sincere gratitude to the respected chief guest Mr. Shankar Koirala, the secretary-Ministry of Industry for being with us for accepting our request as chief guest of the function.

We are here in the rostrum because the members of the Nepal Geological Society have accepted our nominations and elected for 15th executive committee, hence we are duly indebted to all of the members of the society. Please do accept our hearty thanks and gratitude.

I would like to thank all the ex-presidents of Nepal Geological Society whose vision and hard work has instrumented the Society to this height of development and its contribution towards the development of geosciences in Nepal. We are equally thankful and pay humble respect to the honorary members of the society for being with us, despite their busy schedules.

This 31 year old Nepal geological society, from the date of its establishment has been actively engaged for the development and promotion of geosciences in Nepal. Its contribution towards the development of nation through various geoscientific activities, promotional activities of the geoscientist, and geosciences in Nepal is well known to all of us. It has been possible only due to the long vision and hard workings instrumented by the previous presidents and executive committees with continued support from the society members and all sphere of geoscientific communities, either national or international. This has turned the present Nepal Geological Society as one of the most prestigious professional society of Nepal. Therefore, in this occasion I would like to take this opportunity to thank you all the past presidents and executive committees including that of 14th executive committee.

We the newly elected 15th executive committee is here with full devotion and commitment for the further development of the society. We pledge to work hard with new enthusiasm and endeavor for continued contribution on geoscientific development, development of the geoscientist and on the national development.

None of these works are possible until we get due support from all the members of the society. Besides, we too seek the continued support from other sphere like Government of Nepal, non-governmental organizations, private sectors, professional organizations, national and international agencies etc. In this context, we very much expect your cordial cooperation, active participation, constant guidance, and valuable suggestions from all of the members of the society in all spheres of our activities for the betterment of the society, development and promotion of the geosciences and geoscientist and national building process.

The outgoing president of 14th executive committee, Mr. Jagadis Nath Shrestha has already highlighted the activities of the society carried out during his tenure. Now, it will be our duty to complete all the activities that has been started. In addition to that the 15th executive committee will carry out its programs and activities to keep the society to its optimum status.

In this regard some of the targeted responsibilities of the 15th executive committee as we feel are:

Organization of the 27th Himalayan Karakoram-Tibet (HKT) Workshop

The Nepal Geological Society has been accepted for organizing the 27th Himalayan Karakoram-Tibet (HKT) Workshop by 26th Himalayan Karakoram-Tibet workshop held in Canada 2010. Accordingly, the Nepal Geological Society is going to organize 27th Himalayan Karakoram-Tibet (HKT) Workshop in Kathmandu from 29th to 30th Nov. 2012. At present, a small three member organizing committee has been constituted which will be expanded later.

Dr. Dibya Ratna Kansakar is nominated as the Convener of the workshop.

In this connection I would like to inform that the society had successfully organized the Ninth Himalayan Karakoram – Tibet (HKT) Workshop in past.

Land acquisition for office building and geo-science library

Despite the continuous effort to acquire the land for its own building of NGS since the time of its establishment, we are not yet able to acquire it. We will put our maximum effort to obtain a small piece of land to build the NGS office in the premises of Department of Mines and Geology. In this regard, I have set forth the problems not only to the Director General of Mines and Geology only but also to the Respected Secretary of Ministry of Industry, Mr. Shankar Koirala. Both of them are very positive and have assured to help in this matter.

Recognition from Nepal Engineering Council

The Public Service Commission of Nepal categorizes all geo-science faculties to the Engineering Sewa for the enrollment to the government job. Hence, Nepal Engineering Council should duly provide recognition as Engineers to all of the geosciences faculties. In this context, the geological faculty with its various groups and sub groups under Engineering Sewa also must be recognized by the Engineering Council. At present the council provides recognition only to some of the groups appended with engineering words such as "'Engineering Geologist, geotechnical engineer, mining geology, mining engineer" etc. Other geological faculties, which are categorized to Engineering Sewa by Public Commission of Nepal such as pure geology, applied geology, geophysics; seismoloy etc. also should be given recognition by the council. Present executive committee will put its maximum efforts to solve this problem.

Interaction with the stake holders

Disseminating the application of geo-scientific knowledge from the stakeholders to policy makers is very important aspect at present context. Lack of proper understanding of geosciences and haphazard industrial and infrastructural development together with improper policy and planning has created a kind of havoc to all spheres of stakeholders in the near past. Interaction and information dissemination with the entrepreneurs and policy planners will help in proper understanding, coordination and execution of the development works through proper application of geosciences and formulation of policy and plans. For example the recent burning issues are

- Mining of construction material such as aggregates, sand, boulders near big cities such as Kathmandu, Pokhara etc,
- The extraction of construction material from the rivers of Terai area and exports to India
- Crusher industries
- Haphazard construction of hilly roads
- Mining industries, such as limestone, talc etc.
- Hydropower and other infrastructural development

These issues need due interaction between the stake holders and the planners for the upliftment of the economic growth by sustainable development activities with minimal of environmental wear and tear.

The 15th executive committee will put its maximum efforts to find out the real facts regarding the topics mentioned above through the interaction of the stakeholders, geoscientists and planners and set forth guidelines to solve the problems.

Employment generation

Maximum efforts will be paid to seek cooperation to create employment generation for the geoscientist in the governmental as well as nongovernmental organizations such as different ministries and departments of Nepal Government, District Development Committees, Mines and mineral sectors, and mineral based industries.

The 15th executive committee will set forth its strength to maintain high standards in all its regular activities of the society such as organizing ISDR day, organization of thematic workshops, lectures and training programs, publication of bulletins, journals, proceedings of seminars, advocacy for the betterment of the geoscientist, development of the nation through natural resources, preservation of environment and responding to the natural disaster etc.

We, the 15th executive of Nepal Geological Society feels that none of the activities mentioned above could be carried out without the continuous support from the concerned members of the society, governmental organizations, nongovernmental organizations, other professional organizations, national and international agencies, engineering consulting firms, mineral based industries, etc. that have continuously supported the Society so far. We hope all of them will support our society in the coming days to come.

Your valued presence here this evening provides us the encouragement to do all these works. We attach great importance to your opinion, advice, guidance and critique, formally or informally, during this evening and in times to come. We will always be ready for any dialogue and communication for the application of the geosciences in the national development, in the field of providing services to the common Nepalese with our geoscientific knowledge and expertise.

Thank You.

Best wishes for the grand success of

An International Conference on the Geology of Himalaya-Karakoram-Tibet Region

27th Himalaya-Karakoram-Tibet (HKT) Workshop

28th – 30th November 2012

Kathmandu, Nepal

to be organized by

Nepal Geological Society

नेपाल कोइला व्यवसायी संघ

घोराही, दाङ

NEPAL GEOLOGICAL SOCIETY

Auditor's Financial Report (FY 2067/068 B.S.)

For the Year 33rd Asar 2068

KESHAV RAJ BHATTARAI
Certificate No. "B" 1534
Registered Auditor Membership No. 1967

Auditor's Report
To
Members of
Nepal Geological Society
Kathmandu – Nepal

We have audited the accompanying Balance Sheet of, Nepal Geological Society Kathmandu – Nepal as on Ashad 32 2068 corresponding to 16 July 2011, and the related statements of Income and expenditure account and Balance sheet for the Year ended. Our responsibilities are to express an opinion on these financial statements based on audit. We believe that my audit provide a reasonable basis for my opinion.

1. We have obtained all information and explanation, which to the best of on our knowledge and belief were considered necessary for the purpose for audit.
2. The books of accounts have been maintained as required by law.
3. The balance sheet, Income and Expenditure Account are drawn properly on accordance with records which are made available.

In our opinion, the financial statement give a true and fair view of the financial position of the organization as of Ashad 32, 2068 .

Keshav Raj Bhattarai
Registered Auditor
Place- Kathmandu, Nepal

NEPAL GEOLOGICAL SOCIETY

INCOME & EXPENDITURE ACCOUNT

For the Year 33rd Asar 2068

Expenditure	Amount	Income	Amount
Advertisement	22119.00	Member	8500.00
Audit Fee	10000.00	Journal Sale & Adver.	38250.00
Printing Expenses	248108.50	Registration Fee	357399.50
Seminar & Workshop	2692434.94	Other income	354750.00
Office Expenses	110836.00	Contribution	3147251.60
Miscellaneous Expenses	14705.00	Interested Received	61285.95
Stationary Expenses	78005.00		
Telephone & Internet	21850.00		
Different in $ Rate	98520.91		
Excess of income over Expenditure	670857.70		
Total	**3967437.05**	**Total**	**3967437.05**

Note-US $1=NRs.70.95

Note-US $1=NRs. 70.95 $23797.32 =1688419.85

Note-US $1=NRs. 75.09 $23797.32 =1786940.76

- 98520.91

Treasurer General Secretary President Auditor

CLASS-'B' Cert. No. 1534 Registered Auditor

NEPAL GEOLOGICAL SOCIETY

BALANCE SHEET

For the Year 33rd Asar 2068

Assets	Amount
Bank Account	
Argi. Dev. Bank (Fixed Account)	55000.00
Argi. Dev. Bank (Saving Account)	16930.20
Nabil Bank ($24429.94)	1733304.24
Nabil Bank (Fixed Account)	29000.00
Nabil Bank (Call Account)	1038486.87
Nepal Bank (Current Account)	9949.68
Nepal Bank (Saving Account)	55762.83
Advanced	30000.00
B/ R	6000.00
Cash in Hand	4600.00
Total	**2979033.83**
Last Year Surplus	2306686.13
Excess of Expenditure over income	670857.7
Tax	1500.00
Total	**2979033.83**

Not- US $ 1= NRs.70.95

Treasurer

General Secretary

President

Auditor

CLASS- 'B' Cert. No. 1534 * Registered Auditor *

Best wishes for the grand success of

An International Conference on the Geology of

Himalaya-Karakoram-Tibet Region

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NEPAL GEOLOGICAL SOCIETY
15TH EXECUTIVE COMMITTEE AND OTHER COMMITTEES

15th Executive committee

Mr. Uttam Bol Shrestha	President
Dr. Khum Narayan Paudayal	Vice-President
Mr. Sudhir Rajaure	General Secretary
Mr. Kabiraj Paudyal	Joint Secretary
Mr. Ram Prasad Ghimire	Treasurer
Mr. Kumar K. C.	Member
Mr. Sunil Raj Paudel	Member
Mr. Diwakar Khadka	Member
Ms. Suchita Shrestha	Member
Mr. Kushal Nandan Pokharel	Member
Dr. Subodh Dhakal	Member
Mr. Mahesh Pokharel	Member
Mr. Jagadish Nath Shrestha	Immediate Past President

Advisory Board

The advisory board is to provide advices, suggestions and guidelines during the tenure for the betterment of the Society and its members as well as for improvement of the functions and events of the Society. The advisory board comprises of following distinguished personalities.

Mr. Gopal Singh Thapa
Mr. Nirendra Dhoj Maskey
Mr. Narendra Bahadur Kayastha
Mr. Vinod Singh Chhetri
Dr. Ramesh Prasad Bashyal
Mr. Achyutanand Bhandary
Mr. Amod Mani Dixit
Mr. Krishna Prasad Kaphle
Prof. Dr. Bishal Nath Upreti
Mr. Ramesh Kumar Aryal
Mr. Pratap Singh Tater
Dr. Ramesh Man Tuladhar
Prof. Dr. Megh Raj Dhital
Mr. Jagadish Nath Shrestha
Prof. Dr. Madhav Prasad Sharma
Prof. Dr. Prakash Chandra Adhikary
Mr. Padma Lal Shrestha

NGS – ISDR Council

Mr. Siddhi Pratap Khan	Coordinator
Mr. Sagar Kumar Rai	Member
Dr. Rajendra Prasad Bhandari	Member
Dr. Kamala Kant Acharya	Member
Dr. Jaya Kumar Gurung	Member
Mr. Ashish Ratna Shakya	Member
Mr. Surendra Man Shakya	Member
Mr. Sudhir Rajaure (EC)	Member

Editorial Board

The Editorial Board is responsible for publication of journals, bulletins and other publications of the society with its standards and norms. The board comprises of following distinguished personalities.

Dr. Lalu Prasad Paudel	Chief Editor
Prof. Dr. Kazunori Aarita	Editor
Prof. Dr. Erwin Appel	Editor
Mr. Jayandra Man Tamrakar	Editor
Mr. Nir Shakya	Editor
Dr. Rajendra Prasand Bhandary	Editor
Dr. Subodh Dhakal	Editor
Dr. Kamala Kant Acharya	Editor
Dr. Basant Raj Adhikari	Editor
Mr. Kushal Nandan Pokharel (EC)	Editor

Communication and Information Committee

The Communication and Information Committee is responsible for dissemination of all kinds of information, news and notices of society trough its website, and its regular update and maintenance. The committee comprises of following distinguished personalities.

Dr. Ranjan Kumar Dahal	Coordinator
Mr. Dinesh Nepali	Member
Mr. Surya Prakash Manandhar	Member
Ms. Shova Singh	Member
Dr. Prakash Das Ulak	Member
Mr. Sudhir Rajaure (EC)	Member
Mr. Kumar K. C. (EC)	Member

Scientific Committee

The Scientific Committee is responsible for identifying issues to be incorporated in the scientific activities of the society, organizing and conducting scientific talk program, as well as give guidance in preparing yearly work plans of the executive committee. The committee comprises of following distinguished personalities.

Prof. Dr. Vishnu Dangol	Coordinator
Mr. Ramesh Kumar Aryal	Member
Prof. Dr. Megh Raj Dhital	Member
Dr. Rajendra Bahadur Shrestha	Member
Dr. Tara Nidhi Bhattarai	Member
Dr. Naresh Kaji Tamrakar	Member
Mr. Jeevan Lal Shrestha	Member
Mr. Sushil Pradhan	Member
Mr. Upendra Man Singh Pradhan	Member
Mr. Subas Chandra Sunuwar	Member
Mr. Ichha Kumar Shrestha	Member
Mr. Babu Raja Aryal	Member
Dr. Danda Pani Adhikari	Member
Dr. Khum Narayan Paudayal (EC)	Member

Standard Development Committee

The Standard Development Committee is responsible to identify the area that need development of standards of geo-scientific works, accordingly develop norms, standards, and code of ethics as per legal provision and communicate with NGS executive committee. The committee comprises of following distinguished personalities.

Mr. Jagadish Nath Shrestha (EC)	Coordinator
Prof. Dr. Bishal Nath Upreti	Member
Prof. Dr. Vishnu Dangol	Member
Dr. Santa Man Rai	Member
Mr. Bharat Mani Jnawali	Member
Prof. Dr. Ram Bahadur Sah	Member
Mr. Pratap SinghTater	Member
Mr. Hifzur Rahman	Member
Mr. Dharma Raj Khadka	Member
Mr. Achyut Koirala	Member
Mr. Narendra Khattri	Member
Mr. Rupak Kumar Khadka	Member
Mr. Kabiraj Paudyal (EC)	Member

Public Relation and Financial Committee

The Public Relation and Financial Committee is responsible to coordinate with other professional organizations, INGOs; NGOs, and GOs, help to raise funds to conduct different activities of NGS (seminars, symposium/ workshop/talk program/ publication material for public interest etc.), and organize activities to increase inter-action and relation between the society, its members and other organizations. The committee comprises of following distinguished personalities.

Mr. Krishna Prasad Kaphle	Coordinator
Prof. Dr. Bishal Nath Upreti	Member
Mr. Pratap Singh Tater	Member
Dr. Dinesh Pathak	Member
Mr. Govinda Sharma Pokharel	Member
Mr. Moti Bahadur Kunwar	Member
Mr. Shankar Giri	Member
Mr. Debi Nath Subedi	Member
Mr. Keshav Kunwar	Member
Mr. Naryan Singh	Member
Mr. Tuk Lal Adhikari	Member
Mr. Ramashis Mandal	Member
Dr. Sandip Shah	Member
Dr. Gyanendra Lal Shrestha	Member
Mr. Shiva Kumar Sharma	Member
Mr. Pradip Kumar Mool	Member
Mr. Jayendra Man Tamrakar	Member
Ms. Suchita Shrestha (EC)	Member
Mr. Ram Prasad Ghimire (EC)	Member

International Relation Committee

The International Relation Committee is responsible to explore different possibilities towards the internationalization of NGS through disseminating information about the NGS, and help NGS to raise fund by coordinating to carry out joint activities with foreign societies and institutions. The committee comprises of following distinguished personalities.

Dr. Suresh Das Shrestha	Coordinator
Prof. Dr. A. K. Sinha	Member (India)
Dr. Pitambar Gautam	Member (Japan)
Dr. Damayanti Gurung	Member (USA)
Mr. Jeevan Bajra Bajracharya	Member (UK)
Mr. Moti Bahadur Kunwar	Member
Dr. Indra Lal Jworchan	Member (India)
Mr. Umesh Shakya	Member (Laos)

Dr. Rajeev Gautam	Member
Dr. Arjun Aryal	Member
Prof. Dr. Jean Philippe Avouac	Member (France/ USA)
Dr. Anne F. Sheehan	Member (USA)
Mr. Diwakar Khadka (EC)	Member

Rules and Regulation Committee

The Rules and Regulation Committee is responsible to review existing rules and regulation of the NGS, suggest for necessary amendments in the rules and regulation and draft rules and regulations if necessary. The committee comprises of following distinguished personalities.

Mr. Achyutananda Bhandary	Coordinator
Mr. Upendra Man Singh Pradhan	Member
Mr. Shanmukesh Chandra Amatya	Member
Mr. Sardesh Raj Sharma	Member
Mr. Gyani Raja Chitrakar	Member
Mr. Dilip Kumar Sadaula	Member
Mr. Narendra Khattri	Member
Dr. Prem Bahadur Thapa	Member
Mr. Mahesh Pokharel (EC)	Member

Land and Building Management Committee

The Land and Building Management Committee is responsible to explore different possibilities towards the construction of NGS building, make necessary approach to concerned organizations for acquiring land for building construction, and locate the areas to purchase land if necessary in order to utilize the money of NGS. The committee comprises of following distinguished personalities.

Mr. Sarbjeet Prasad Mahato	Coordinator
Mr. Shyam Bahadur K. C.	Member
Mr. Ashok Kumar Duvadi	Member
Mr. Jay Raj Ghimire	Member
Mr. Shailendra Bhakta Shrestha	Member
Mr. Khila Nath Dahal	Member
Mr. Sunil Raj Paudel (EC)	Member

Ambeshwar Engg. Hydropower Pvt. Ltd.

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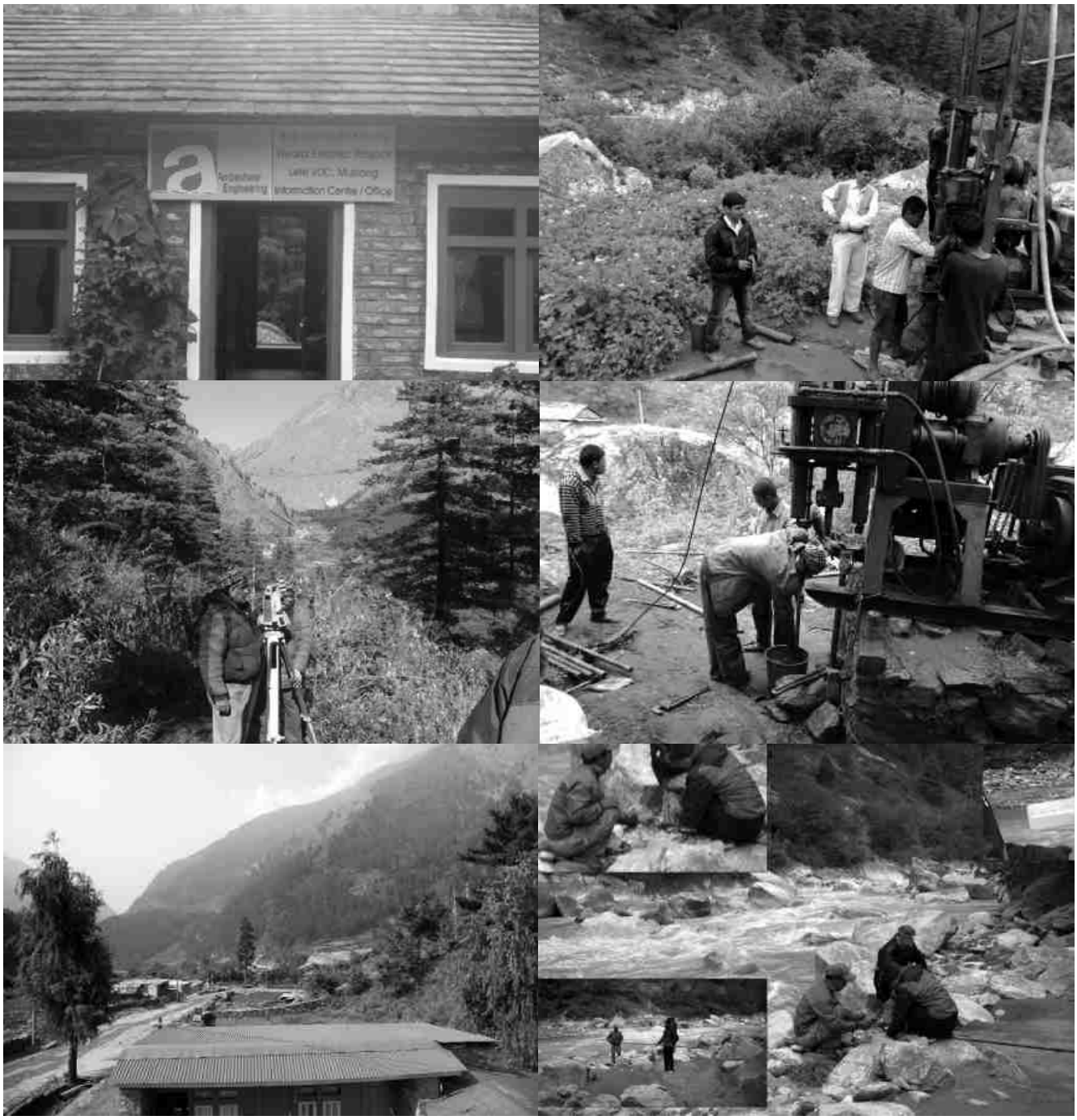

Kaligandaki-Koban HEP, Mustang

INTERNATIONAL DAY FOR DISASTER REDUCTION
IDDR DAY 2011
'Making Children and Young People Partners for Disaster Risk Reduction'

WORKSHOP REPORT

Organized by:

Nepal Geological Society

In association with

Mitra Kunj and Russian Centre of Science and Culture

Supported by: Kathmandu Metropolitan City (KMC)

Kathmandu, Nepal

19 October, 2011

PROGRAMME HIGHLIGHTS OF IDDR DAY-2011

Nepal Geological Society (NGS) has been undertaking various activities related to disaster and disaster reduction in response to the United Nations since l991. In response to the call of (UNISDR), NGS organized a one-day seminar on the occasion of international Day for Disaster Reduction (ISDR) 2011 on Lgth of October 2011. The seminar was held in the Russian Centre of Science and Culture, Mitra Kunja, Kathmandu, Nepal. NGS had requested school children, university students, geoscientists and senior officials of ministries and departments of the Government of Nepal. There were more than 130 participants in the seminar. The seminar was organized into two sessions. The first session was inaugural session and the second was technical session. The technical session was divided into two technical sessions before and after the lunch. Mr. Shankar Prasad Koirala, Secretary, Ministry of industry inaugurated the program. Mr. Koirala stressed on the need of initiation from geoscientists for disaster reduction in a Himalayan country like Nepal. Acting Director of Nepal Bal Sangathan, Mr. Ramesh Bhomi expressed his views over the program and enlightened possible collaboration with NGS on disaster prevention and awareness. There were six technical presentations on natural disaster and their mitigation. Mr. U. B. Shrestha, President of Nepal Geological Society welcomed the participants. The inaugural program was addressed by Mr. S. P. Mahato, Director General, Department of Mines and Geology and finally Mr. S. Rajaure, General Secretary of the society paid vote of thanks.

INAUGURAL SESSION

The ISDR Day-2011 was inaugurated by the Mr. Shankar Prasad Koirala, SecretaryMinistry of Industry, Government of Nepal. The participants were welcomed by the convener of the ISDR Day-2011, Mr. Siddhi Pratap Khan. Chief guest and different dignitaries expressed their views on the need of reducing disaster and present programmes and policies of the government in this regard.

Inaguration of ISDR Day-2011 by Mr. Shankar Koirala, Secretary Ministry of Industry

Participants of the ISDR Day-2011

Participants interacting with Mr. Shankar Koirala, Secretary Ministry of Industry during the tea break

TECHNICAL SESSION

The technical session was chaired by Mr. K. P. Kaphle and Mr. Upendra Bhakta Pradhananga. Five thematic papers were presented in the technical session. The abstracts of the papers are given at the end of this report.

WRAP UP SESSION

Various renowned geoscientist like Mr. N.D. Maskey, former president of the society concluded the session with highlightening the importance of the seminar. The representing officer of the Nepal Army had highly apreciated the about the information about GLOF (Glaciar Lake Outburst Flood) and informed that the Nepal army will inform all the concerned site offices to take necessary precaution regarding safeguarding the people.

CONCLUSIONS

Nepal is prone to varieties of natural disasters. It is always better to mitigate the impact of unwanted disasters. Need of awareness of natural disasters was stressed on the occasion by many speakers. In accordance with the theme given by

UNISDR, young children and students' were invited as prime target and their participation was meaningful. The target of the program, the school students were expressing their views that they benefited from the program and stressed on the need for the continuation of such programs in the days to come so that awareness could be created in the society through children and young people.

Awareness of disasters should start from the very beginning of school level. Strong need was felt to suggest the concerned agencies to incorporate all kinds of disaster and their possible mitigative measures.

ABSTRACTS OF PAPERS PRESENTED DURING THE INTERNATIONAL DAY FOR DISASTER REDUCTION (IDDR)

Management of landslide hazard in community level - a concept for children and youth partnership

Ranjan Kumar Dahal

Tribhuvan University, Tri-Chandra Campus, Department of Geology, Ghantaghar, Kathmandu, Nepal

Development that meets the demand of the present without ignoring the demands and options of the future is said to be sustainable. There should be a balance between the present and future works for minimizing environmental degradation. Actually, sustainable development has three component, namely, economic development, social development and environmental protection. The infrastructure development on mountain slopes and use of slopes for agricultural practice are two basic economic development procedure of developing country like Nepal. Since the mountain slopes are very vulnerable for landslides, landslide hazard assessment should be considered as part of any developmental process on mountain slopes. Till now this kind of study is almost rare in Nepal from both governmental and private authorities. Therefore, this paper is high lighting suitable methods for landslide hazard study with some illustrative case studies. The management procedure of landslide hazard in the area are also discussed in the paper.

Considering the accuracy of the zonation maps of case studies, this paper appeal for similar practice during planning of infrastructures on the Nepalese mountain slopes. Conceiving recent strategies of development of Nepal and encouraging from accuracy of the zonation maps discussed in cased studies, some proto-type landslide hazard maps are also proposed for use in village communities of Nepal with youth and children partnership, which will certainly help to reduce landslides calamities in villages and cities of Himalayan mountain slopes.

Seismological overview of the earthquake of 18 September Taplejung – Sikkim border region

Soma Nath Sapkota

National Seismological centre, Department of Mines and Geology, Kathmandu, Nepal

An earthquake of 6.8 in local magnitude has struck in the evening of September 18 at NST 6:25 PM. Epicenter of this earthquake has been reported to be in the eastern boarder region of the Nepal Taplejung and Sikkim. Reported death toll has reached more than 110 by this earthquake out of that 6 in Nepal. Due to mountainous terrain and inaccessibility of the area actual damage is still being reported.

This widely felt earthquake has triggered the Seismic Alert System installed at NSC. Although event was located in NSC by seismologist within 20 minutes of the events, reporting to home ministry and other media was delayed due to the communication problems. NSC has located 136 events within the first 24 hours of the crisis and more than 600 aftershocksby October 6, 2011.

This earthquake has been recorded at theNSC accelerometric network. The accelerograms allowed us to estimate the aggressiveness of the earthquake parameters (such as PGA,PGV, response spectrum …).

NSC has just completed post seismic campaign in eastern Nepal and deployed three accelerometers at Rumjatar, Ilam and Taplejung, four broadband seismic stations at Dhankuta, Jhapa, Ilam and Taplejung and few more campaign GPS site in the area. Data from this deployment will allow us to better constrain the seismic parameter of this earthquake.

Present talk will describe our understanding about this earthquake with the help of NSC existing data as well as introduce the way the post-seismic campaign data will be used to better decipher the processes at work.

Glacial lakes in Nepal Himalayas: The underlying challenges of their study

Achyuta Koirala
Kathmandu, Nepal

The cryosphere of the earth is changing day by day as any other aspects of the earth's surface. The rate of depletion of the snow and ice coverage of the earth has significantly increased for last few decades which are blamed to be the effect of industrialization in different part of the world. Many countries are already listed among the industrialized nations and many more are following to join the list in course of their development. Studies have shown that present atmospheric changes are not only to blame to the effect of industrialization. There are many other factors including the phenomenal changes of the characteristics of the earth imposed by the changes in radiation and magnetic field affecting atmospheric condition of the earth's surface.

Area of snow and ice coverage in the Nepalese Himalayas is decreasing as in other part of the world. Mass wasting from glaciers is obvious and snouts of many glaciers are retreating considerably after the so called Little Ice Age (About AD 1500-1900). The effect of glacier retreat is the formation of glacial lakes mostly dammed by loosely packed with or without ice core moraine dams. These glacial lakes are posing threat to the people and their properties located along the river valleys due to the catastrophic flooding after the outbreak of the lake.

One of the study conducted by ICIMOD in 2010 revealed that there are 1466 glacial lakes covering an area of 64.78 sq. km in Nepal Himalayas. Out of these 21 lakes were found to be potentially critical in terms of Glacial Lake Outburst Flood (GLOF) hazard. Due to the remote location, it is difficult to reach and to perform physical tests and measurements to differentiate and prioritize these lakes into high hazard and low hazard ones. This report deals with the underlying challenges of the study of the potentially high hazard glacial lakes of Nepal Himalayas.

Results of ground radiometric survey, radiation effects and health hazards

Krishna P. Kaphle
Panipokhari, Maharajgunj, Kathmandu, Nepal

Out of more than 85 Uranium (U) minerals and few Thorium minerals known in the earth only very few of them are recorded in Nepal. Favorable host rock for primary sources of Uranium and Thorium are granite, syenite, pegmatite and gneiss in the Higher Himalayan region and sulphide bearing quartzites, black slate/ shale in the Lesser Himalayan region. Secondary source is mainly Pebbly Arkosic sandstone in the Siwalik (MS2 and US)/ Sub Himalayan region. More than 50% of the known U deposits are of sedimentary origin. All radioactive minerals emit Alpha, Beta and Gamma radiations. Exposure to over doses of radiation is hazardous to health. Uranium is capable of nuclear fission, therefore it is mainly used as main source of nuclear energy, and also utilized in nuclear weapons, nuclear medicine, technical and industrial appliances, agriculture, age dating of rocks and many other purposes in this developing world. So far there is no operating mine and atomic reactor/ industry in Nepal where we can utilize Uranium, and the government have also not yet given priority for its exploitation.

Preliminary Ground radiometric survey (10,000sq.km) in some parts of the Siwalik foothills, some parts of the Lesser Himalaya in Far-western Nepal, and northern part of KTM valley were able to trace some scattered irregular radioactive bodies locally rich in Uranium minerals. Systematic follow up exploration in selected parts of Central Siwalik covering 1200 sq km area confirmed existence of radioactive minerals in pebbly arkosic sandstone in Buka Khola in Sindhuli district; Chiruwa Khola, Chandi Khola and Tinbhangale, in Makwanpur; Mardar Khola and Panpa Khola in Chitwan districts. Significant mineralization is recorded only in Tinbhangale where 4 channels Gamma Ray Spectrometer (Gad-6) has revealed TC up to 27,405cps and U_up to 437cps which is more than 100 times of normal background value. U content in stream water (<1ppm), stream sediments (up to 4ppm), residual soil (up to 12ppm) and ore samples (up to 1308ppm) confirmed was by chemical analysis. Tyuyamunite, Carnotite and Coffinite are the chief ore minerals, and other heavy minerals like monazite, ilmenite, zircon and rutile may also contain traces of U & Th in their crystal lattice.

Sandstone type U mineralization in Nepal is similar to Suleiman Range in Pakistan and in some parts Himanchal

Pradesh in India. Most of them are associated with coaly materials/ org. remains with or without Pyrite/ Marcacite in pebbly Arkosic sandstone and in carbonaceous/ lignitic silty shale. High Radioactive Intensity values, uraniferous bright sulphur to lemon yellow surface coloration, association with limonitic layers and fine coal fragments/ organic remains, fairly high specific gravity etc. help to identify the ore.

Preliminary and follow up gold and uranium exploration in Baitadi and Darchula was able to trace a 3 - 8m thick, about 160m long sulphide bearing radioactive quartzite band in Gorang and few lenticular radioactive bodies in Bangabagar, Baghgoth and Jamari Gad section in Baitadi and Boregad, Rugrugad in Darchula, and ore floats of Fe-Cu sulphide ± gold bearing radioactive quarzite in Gorang, Jamari Gad and Chamliya River are the clear indication of presence of radioactive bodies in these area. Radioactive Intensity value measured by Scintillation Counter showed 1000 - 10,000cps (TC) in mineralization band. Presence of Uraninite, cofinite, monazite, rutile and zircon in the radioactive quartzite band in Gorang and in the heavy mineral concentrate samples from Chamliya River and Jamari Gad in Baitadi clearly indicate that Gorang mineralization is prospective for U as well as Au for further detail investigation.

Autonite mineralization in some pegmatite bodies in the northern part of Kathmandu valley also indicate presence of scattered small natural radioactive bodies in this area. Some high radioactive intensity values are also recorded from the river sands in localizes area. Some symptom of preliminary effect of radiation in the local people/ health and in animal is already marked in Tinbhangale, Kathmandu and Gorang. Therefore, detailed investigation of these areas is extremely warranted to delineate the deposits, their size, and uranium content and also know the possible health hazards in the local people. Extreme care must be taken while handling the ores by the professionals and other workers with respect to environmental degradation and health hazards.

Excess dose of radiation during Diagnostic examination (e.g. X-ray, CT scan, Mammography etc.), Therapeutic treatment (chemotherapy etc.) could create an adverse effect and develop cancer. Occupational exposure (Radiology Technicians, Radiologists etc.) incurred during their work in X-ray machine, CT scan equipment etc. may receive higher doses due to negligence in handling the equipments and leakage of radiations that may cause health hazard. Risk of fatal cancers from nuclear radiation is very high.

Issues of groundwater resources in Kathmandu valley

Sagar Kumar Rai
Department of Irrigation, Government of Nepal

Being a capital city of Nepal, about 4 million people are inhabitation in Kathmandu now. Present demand of potable water in Kathmandu is about 320 million liter per day while the supply is about 160 million liter per day only. Thus, Kathmandu is considered as a water deficit or water stress zone. Out of supplying water, about 78.5 million liter is supplying from the groundwater sources and remaining 81.5 million liter is from the surface sources. It means about 50% supplied water is being extracted from the groundwater resources. But the hydrogeological studies reveal that, the annual recharge of groundwater in Kathmandu is about 14.6 million cubic meters (40 mld) only. It indicates that the abstraction rate of groundwater is far more than the recharge rate. Therefore, the groundwater of Kathmandu Valley is being over extracted or mined. The historical stone spouts i.e *Golden Stone Spouts* (Sun Dhara) and *Twentytwo Stone Spouts* (Bais Dhara) including two dozens of traditional stone spouts of Kathmandu show the situation of over extraction of groundwater in Kathmandu. Similarly, most of the artesian wells of Central Kathmandu have also been dried. However, the trend of groundwater abstraction is still increasing instead of decreasing since of rapid growth of population and urbanization. Therefore, Kathmandu is also at the high risk for land subsidence as well.

In one hand, any persons or agencies can easily drill and abstract the groundwater without the permission and in other hands, the groundwater of Kathmandu has been badly contaminating also. Thus, the groundwater of Kathmandu both physically as well as chemically is deteriorating. However, nobody will care and control to them since of lack of government agency and legislation in the country. Therefore*, the formation of responsible government institution and proper legislation in groundwater resources is* the current issue in Nepal. The sustainable development of groundwater resources is impossible without the establishment of institution and legislation. To address the present issue, hydrogeologists and environmentalists of the country are trying to aware and convince specially to politicians, policymakers, decision makers and local people as well. Consequently, the case of this issue has been highlighted up to the level of the Supreme Court and the Natural Resources Committee of the Constitutional Assembly of Nepal. In addition, the *Nepal Hydrogeological Association (NHA*) has also been formed recently for avocation of the present issue.

A GLIMPSE OF FUNCTIONS ORGANIZED BY NEPAL GEOLOGICAL SOCIETY (NGS) TO OBSERVE

UN declared natural disaster reduction decades

Uttambol Shrestha
President, NGS

The United Nations General Assembly in 1989 had declared the decade 1990-2000 as the International Decade for Natural Disaster Reduction and the 2nd Wednesday of October as the International Day for Natural Disaster Reduction (IDNDR-DAY). In this context, the Nepal Geological Society (NGS) had observed the IDNDR-Day, since 1991 by organizing various meetings and seminars. This program had received a national focus with applaud and many governmental and non-governmental organizations had been involved in these occasions. After the completion of the IDNDR decade, the United Nations again declared to observe the International Strategy for Disaster Reduction on the same day since 2001. In compliance with UN declaration, the society also continued to observe the ISDR-Day since the very first year of declared ISDR-Day, 2001.

All the activities of the society are conducted in coordination and support from various governmental, nongovernmental and international organization such as Ministry of Home Affairs, Government of Nepal; Disaster Mitigation Support Program/ UNDP Nepal, all relevant consulting firms, NGOs, INGOs and professional organizations etc. The table below provides the synopsis of all the activities.

The 15th Executive Committee of Nepal Geological Society will conduct the program through its ISDR organizing committee formed under the convener of Mr. Siddhi Pratap Khan, Joint Secretary, of the Department of Irrigation and life member of the society. We are dedicated to organize this day with full of enthusiasm and endeavor. In this context, we request to all of the concerned government, nongovernment, international and national organization to provide us the same cooperation and coordination both morally and financially as we were getting previously.

S. N.	IDNDR/ISDR Year and theme	Organizer and partners	Chief guest and speakers	Main activities
1	7th Oct., 71991: One day seminar cum workshop on "Geological Hazards, Environment and Man Made Structures" Ref: NGS Bulletin 10	EC/UNDP, EAST, GEOCE, , ITECO, MULTI, SILT, SSNCC	Chairman, Mr. M. R. Sharma Mr. R. K Aryal, Mr. Amod Mani Dixit	Six technical papers related with the theme is presented.
2	14th Oct 1992: Geological Hazards and Environmental problems in Nepal	UNDP, MoI/GN, DMG	Hon. State Minister, MoI/GN, Mr. D. M. Serchan graced Chief Guest Prof. Dr. Edmond Ktauter, Vice Chairman of EC/ IDNDR Mr. G. B. Tuladhar, Mr.K. P. Kaphle	One day seminar cum workshop
3	Oct, 1993: National Meeting and Seminar on Geoscientific inputs in Natural Disaster Management Ref: NGS Bulletin 11	UNDP, CGS, MoH/ GN, DPTC, TU, DMG Nepal Scouts	Hon. Home Minister Mr. Sher Bahadur Deuba Ms Caroll C. Long (UNDP resident representative Mr. H. Oi (JICA), Mr. R. B. Shrestha, Mr. C. k. Sharma, Mr. D. R. Pant, Mr. D. R. Kansakar, Mr. A. S. Dhakal, Mr. K. Karki, Mr. A. Koirala, Mr. S. Dhital, Mr. U. Shakya, Mr. T. P. Adhikari, Dr. T. M. Tandukar, Dr. S. Matsuura, Mr. M. S. Khadka, Mrs. R. Shrestha, Mr. A. M. Dixit, Mr. K. P. Kafle	National meeting cum seminar with various paper presentations
4	5th Oct., 1994: A safer world for 21st century : Reduce Vulnerability Ref: NGS Bulletin 12	NGS, UNDP,	Dr. Ram Prasad Yadav (Member-NPC) Mr. W. S. Berger (UN/DMS) Mr. H. Oi (JICA), Mr. S. N. Upadhyaya, Mr. K. P. Kaphle, Mr. A. M. Dixit, Mr. R. B. Shrestha	Technical discussion A resolution passed to submit to the policy and decision makers of then HMG and INGOs.

5	11th Oct. 1995: Women and Children: Key to Prevention Ref:NGS Bulletin 13	NGS, UNDP DPTC, JICA	Hon. Home Minister Mr. K. B. Khadka Mr. Rebatirman Pokharel Mr. Larry Maramis (Deputy Resident representative of UNDP) Mr. D. R. Kansakar, Mr. D. R. Kansakar, Mr. S. P. Rimal, Mr. J. Tuladhar, Mr. R. K. Sharma, Dr. R. B. Shrestha	Technical discussion were done with various aspects related to natural disaster, A resolution was passed from the participants to be submitted to the policy and decision makers of then HMG and INGOs.
6	9th Oct. 1996, Understanding our physical environment: Key to Disaster Reduction Ref:NGS Bulletin 14	NGS, UNDP, NNC/ INDRD, MoH/GN	Hon. Assistant Home Minister Mr. D. P. Banskota Mr. W. Berger (UNDP) Dr. B. N. Upreti, Mr. A. M. Dixit, Mr. P. L. Singh Mr. G. S. Thapa, Mr. M. Paudel	Twelve technical papers presented and discussed A resolution was passed from the participants to be submitted to the policy and decision makers of then HMG and INGOs.
7	6th Oct., 1977 Water too much too little: Leading cause of Natural Disaster Ref:NGS Bulletin 15	NGS, UNDP, NNC/ INDRD, MoH/GN	Mr. R. R. Pokharel, Secretary, Ministry of Home Affairs Mr. W. Berger (UNDP) Mr. Todd Stowell (LWS) Dr. B. N. Upreti, Mr. A. M. Dixit, Mr. Keshav Sthapit, Mr. N. B. Kayasta, Mr. K. S. Yogacharya, Mr. G. K. Shakya, Mr. M. Paudel	Technical discussion were done with various aspects related to natural disaster,
8	14th Oct, 1998: Natural Disaster Prevention and Media: Prevention begins with information Ref:NGS Bulletin 17	NGS, NNC/INDRD, MoH/GN, IDWDL DPTC, NSET, UNDP, LWF	Hon. Home Minister Mr. G. P. Joshi Mr. Bill Berger (UN/DMS) Mr. A.K Aryal, Mr. A. M. Dixit Mr. G. S. Thapa, Mr. Mukunda Paudel Mr. A. M. Okamoto, Mr. Uttam Bol Shrestha	Nine technical papers on various aspects related to various types of disaster and environmental degradation were presented. Training for three days: Disaster Journalism and poster publication 1998 - UN Merituous Certificatefor the Disaster Prevention Awrded to NGS
9	13 Oct, 1999: Prevention Pays Ref:NGS Bulletin 18	NGS, NNC/INDRD, MoH/GN, DPTC, UNDP Nepal, LWF	Mr. P. P. Pokharel, Secretary, Ministry of Home Affairs Mr. Kozi Kame (Chief advisor DMSP) Mr. A. M. Dixit, Mr. P. B. Malla, Mr. K. R. Aryal, Mr. N. R. Sthapit, Mr. M. B. Karki, Mr. Uttam Bol Shrestha	Eight technical papers on various aspects related to various types of disaster and environmental degradation were presented
10				
9	10th Oct, 2001: Ref:NGS Bulletin 19	NGS, JICA, NNC/ INDRD, MoH/GN, DMSP	Dr. J. C. Pokharel (Member-NPC) Dr. Kozi Kami (JICA) Mr. N. R. Sthapit, Mr. B. R. Shakya, Prof. Dr. B. N. Upreti Mr. D. Bhattarai, Mr. M. B. Paudel Chhetri	Three working papers were presented
10	9th Oct., 2002 Ref:NGS Bulletin 20	NGS, NNC/INDRD, MoH/GN , DMSP, DWIDP, DMG, UNDP, NSET	Dr. J. C. Pokharel (Member-NPC) Mr. Tika Dutta Niraula, Mr. S. P. Tater,Mr. R. K. Aryal Mr. N. R. Sthapit, Mr. A. N. Mishra, Mr. R. P. Khanal Mr. P. R. Joshi, Prof. Dr. M. P. Sharma	Ten working papers were presented
11	13th Oct. 2004: Learning from today's disaster for tomorrow's Hazards	NGS, NNC/INDRD, MoH/GN, DMG, UNDP, DWIDP, NSET, Action aid Nepal	Hon. State Minister for Water Resources Mr. Thakur Prasad Sharma Mr. Sital Babu Regmi, Dr. R. Man Tuladhar Mr. R. K. Aryal, Mr. S. B. Pradhanang, Mr. L. M. Rimal	Thirteen technical papers were presented
12	19 Oct, 2005: Increasing Disaster Resilience using Microfinance and Safety Nets Ref:NGS Bulletin 23	NGS, UNDP, NNC/ INDRD, MoH/GN	…… Convenor: Mr. R. M. Tuladhar	More than 50 geologist And several intellectuals working and financial and other MULTIdisciplinary sector participated
13	18th Oct. 2006: Disater Reduction Begins At school Ref:NGS Bulletin 24	NGS, UNDP, AA/ Nepal, SC/Nepal, NSET, Indrajyoti Primary School	…… Convenor: Mr. R. M.Tuladhar	More than 50 geologist and several intellectuals financial and other multidisciplinary sector participated, 14 disater related technical papers were presented

14	10 Oct. 2007: Disater Risk Reduction Begins At school Ref:NGS Bulletin 25	NGS, DPNet Nepal, UNDP/ Nepal, EU, AA/Nepal, Oxfam, GEF	Hon. Finance Minister Mr. Ram Saran Mahat Mr. Bijaya Singh (ARR UNDP Nepal) Mr. Pratap Kumar Pathak, Mr. M. B. Chhetri, Dr. D. P. Adhikary,Mr. B. N. Urpety, Mr. Luv Prasad Tripathi	Interschool art competion on the theme: Prakop , Hami ra Hamro Sansar, Nine technical papers were presented
15	22th Oct. 2008: ……..	NGS, GoN	Hon. Deputy Prime Minister and Home Minister Mr. Bam Dev Gautam	A workshop on Koshi Flood Disaster was held Ref:NGS Bulletin 26
16	28th Oct, 2009: Reduce Risks: Protect Health Facilities, save lives	NGS, KMNC, Kathmandu	Dr. Govinda Kusum, Secretary: Ministry of Home Affairs Dr. Dinesh Pathak, Dr. B. B. Singh, Dr. Jaya Kumar Gurung, Mr. J. N. Shrestha Mr. Ganesh Saha (former Environment Minister)	Technical papers related to disaster were presented Ref:NGS Bulletin 27
17	27th Oct. 2010 Making Cities Resilent- My city is getting ready	NGS, KMNC, Kathmandu, LSMC, Russian Culture Centre	Mr. Ananda Raj Pokharel (Secretary GoN) Dr. Dinesh Pathak, Dr. Jaya Kumar Gurung Dr. B. B. Singh, Mr. S. P. Mahato, Mr. J. N. Shrestha Mr. Arjun K. Thapa,Mr. S. R. Sharma, Mr. G. S. Thapa	Technical papers related to disaster management were presented
18	13th October, 2011 Making Children and Young People Partnersof DisasterRisk Reduction	KMNC, Kathmandu, DWIDP, NGS Russian Culture Centre	Mr. Shankar Prasad Koirala (Secretary, Min. of Industry, GoN), Mr. S. P. Mahato, Uttam Bol Shrestha, Mr. Siddhi Pratap Khan, Mr. Nahendra Pradhan etc.	Seven technical papers related to different disaster and making children and young people partners of disaster risk reduction are presented. Students from some public schools, Nepal Scout, and campuses also participated in the seminar.

N.B: NGS: EC/UNDP: NNC/INDRD: Nepal National Committee for INDRD, Action Aid Nepal: AA/Nepal; Save the Children,Nepal: SC/Nepal

ABSTRACT OF PAPER PRESENTED IN SCIENTIFIC TALK PROGRAMMES

New findings of the Kathmandu groundwater basin in Nepal

Yokito Sugimura
Japan Water Agency (JWA)

Groundwater is a major source of water supply in Kathmandu Valley, in which capital of Nepal with the population of 2.7 million people is located. Uncontrolled and haphazard urban growth, insufficient municipal water supply, increase in economic activities, changes in life style of the people, lack of enforcement of rules and regulations have resulted in dramatic increase of water demand in the Valley resulting in extensive groundwater mining of about 60 MLD (Source: Melamuchi 2001) which is 4 times bigger than critical recharge rate of 15 MLD (JICA, 1991).

In order to use groundwater in sustainable way, understanding of the hydro geological structure of groundwater basin is essential. Hydro geological structure gives a picture of special distribution of groundwater and interrelationship with geological structure.

In early 2000's two Japan-Nepal collaborative research projects were carried out. One of two was "Uplift of Himalayas and its induced Global Environmental Changes (in short Palaeo-Kathmandu Lake Project)" led by Prof. Harutaka Sakai, Kyushu University (now Prof. of Kyoto University). These studies were done in cooperation with Tribhuvan University, Nepal Geological Society and Department of Geology.

In the TA mentioned above, we have carried out a supplementary study on "Groundwater management in Kathmandu Valley" and following three new findings were revealed:

Hydrogeological Mappings

Based on this latest interpretation of geological structures of the Kathmandu Groundwater Basin, we challenged to find out three dimensional hydro-geological structures by drawing fifteen (15) geological cross sections using grid system covering whole groundwater basin in the Valley. This is the first systematic challenge to throw light on three dimensional hydro-geological structures in the Valley.

A new groundwater district: Chandragiri buried Valley

Three dimensional hydro geological mapping has discovered a new groundwater development potential district tentatively named "Chandragiri Buried Valley" with calcareous Chandragiri Mountain Range with the C.A. of 55 km2 in south western Valley.

Ground Subsidence

By the interferometoric analysis using the data from PALSAR equipped on the Advanced Land Observing Satellite (ALOS, JAXA), a couple of ground subsidence bowls with maximum subsidence speed of 15 -10 cm/year were identified in Kathmandu and Patan. The developed hydro geological maps could clearly show that major land subsidence areas correspond to the area where a large amount of groundwater are abstracting and thick Kalimati Formation are laid on subsurface.

Fingerprinting Himalayan convergence accommodation processes

Kyle Larson
University of Saskatchewan, Canada

Conceptual models of convergence accommodation processes that operated during the Tertiary evolution of the Himalayan orogen have commonly been examined from an 'end member' point of view. Many previous studies have used geologic data to attempt to characterize these processes in terms of either channel flow or wedge taper models. These models, however, are not mutually exclusive [1] as supported by recent field-based research that demonstrates they are intrinscially related both spatially and temporally [2,3]. Key to undertanding the relationship between channel-type mid-crustal flow and wedge taper processes is appreciating the spatial variation in displacement and distortion throughout a large, hot orogen. Moreover, it is also critical to recognize how initially spatially and deformationally distinct domains may be later juxtaposed.

Best wishes for the grand success of

An International Conference on the Geology of Himalaya-Karakoram-Tibet Region

27th Himalaya-Karakoram-Tibet (HKT) Workshop

28th – 30th November 2012

Kathmandu, Nepal

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The exhumed metamorphic core of the Himalaya is well exposed in the Manaslu-Himal Chuli region of central Nepal. This transect has been subject to much geologic research including spatially expansive P-T determinations and new geochronologic controls. These data, coupled with detailed mapping that covers most of the exhumed metamorphic core, provide the constraints necessary to characterize the convergence accommodation processes that imparted those characteristics. The lower portion of the exhumed mid-crust is characterized by structurally-downward decreasing P-T conditions and monazite ages interpreted to reflect subcretion of material to the base of the mid-crust as it was exhuming, consistent with wedge taper processes in the shallow foreland [2]. The upper portion of the exhumed mid-crust, however, preserves a condensed right-way up pressure gradient, an invariant temperature gradient, and monazite ages that are consistent with ductile mid-crustal flow in the deep hinterland [3]. The present-day juxtaposition of these two contrasting domains and the characteristics they record is compatible with the crustal scale channel flow models of Jamieson et al. [4]. Channel flow and wedge taper processes are, therefore, not mutually exclusive.

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Theoretical seismograms for 3-D heterogeneous models with variable surface curvatures: Torsional modes

Gyanendra Gurung

Chonbuk National University Graduate School

Department of Earth and Environmental Science

Modern computational hardware and Internet (network) communications have led to an advanced multimode seismic procedure for 3D mapping of realistic structures. The four-part method involves: construction of an initial 3D structure, static computations, wavefront-propagation computations (the aspects of which are treated here), and inversion for an improved structure. Presented earlier, the static computations assign a full, azimuthally-dependent, propagating-mode (spheroidal and torsional) specification to each latitude-longitude location of the geographical region. The wavefront-propagation computations combine the results of the preceding step to include the epicenter-to-receiver, surface-raypath history for each triplet (frequency, mode number, surface azimuthal direction of propagation) in the formation of the theoretical seismograms. The interplay of our fundamental assumption, and modal lateral scattering, are the key elements in these computations. The fundamental assumption for modal treatment of a 3D varying structure with variable curvature, is that each frequency-mode-azimuth triplet at a location can be assigned its own specific laterally-homogeneous structure and radius of surface curvature. The extent of the true structure we currently use for this is defined by the modal depth of penetration D, and the vertical cylinder with diameter equal to Kappa times this depth of penetration (S/D = Kappa). Extensive testing has now verified our earlier, preliminary estimates: direct comparison with finite-difference results shows $0.80 < \text{Kappa} < 2.50$, i.e. the triplet-specific extent of the true structure is essentially the hemisphere of radius D beneath the surface location. Here, we also report on the attainable accuracy of our wavefront-propagation results—of our theoretical seismograms. Previous work has shown that the results from our (1) static computations, combined with (2) wavefront-propagation computations in which the accuracy effects of modal lateral scattering are suppressed, yields 3.5 sig. fig. in amplitude and phase spectra. Under our initial lateral-scattering assumptions and receiver placements (below), for phase accuracy we have attained at least 2.8-3.5 sig.fig. for Moho downdip propagation, and at least 2.8-2.9 sig.fig. for Moho updip propagation; for amplitude accuracy, at least 1.3-1.8 sig.fig. for downdip propagation, and at least 1.4-1.8 sig.fig. for updip propagation. These accuracies are determined by the limitations of the reference results, and imply only lower bounds on the modal accuracies. Using the extended Himalaya, we compare experimental recordings with our theoretical seismograms from an initial set of simplifying assumptions: geodesic modal surface raypaths, no cross-scattering of modes, single scattering at each of the closely-spaced vertical interfaces (used in the modelling of lateral heterogeneity), and only direct transmission from epicenter to receiver. For the characteristic lateral heterogeneity of the Himalaya, the level of validity of these assumptions is demonstrated as a function of far-side distance of the receiver—relative to a near-side epicenter—from this major heterogeneity.

Present scenario of morphological development of the Bagmati river Kathmandu basin, Lesser Himalaya

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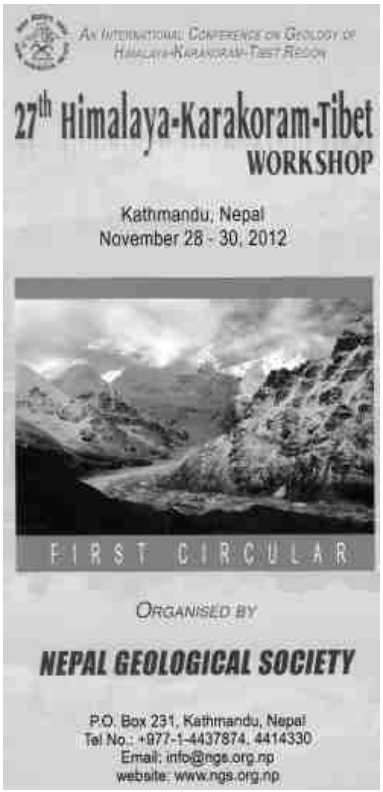
Rivers are significant geomorphological agent showing diversity in form and behavior and quickly responding to disturbances acting against their system. The Bagmati River of the Kathmandu Basin, which originates from eastern hill Nagarkot in Sudal, is the seventh order drainage and stretches about 51 km and flows over the valley covering 678 km^2 of watershed. Several anthropogenic activities as channelization, sediment excavation, effluent discharge, dumping waste in and along the river bank, building roads etc. are heading the river towards a narrow and passive channel. Also, gradual changes in rainfall and river discharge trend also affecting the river morphological development. Comparative study of river morphology from 1992 and 2009 indicates that the river morphology is changing abnormally. The reduction in river discharge and stream power results from natural and anthropogenic causes has caused to increase the sinuosity of river. But stream length, belt width, meander wavelength and radius of curvature diminished. Total channel length is increased by 10 km. This shows that the river is being deteriorated with time. Not only the mainstem Bagmati River but also its tributaries are affected from morphological impairment, and hence the river system of the Kathmandu Valley is being degraded. Thus, immediate rehabilitation is needed to preserve and restore natural function of river prior to the unrecoverable situation.

THE 27TH HIMALAYAN-KARAKORAM-TIBET WORKSHOP (HKT), 2012, IN KATHMANDU



Nepal Geological Society is pleased to host the 27th Himalaya- Karakoram-Tibet (HKT) workshop in Kathmandu, Nepal, during November 28-30, 2012. The HKT workshops have been a forum instrumental in the advancement of geologic understanding of this part of the earth. Geoscientists from across the world have contributed and have benefited much from each other during such workshops in the past. It is expected that this forthcoming event will add again one more building block in furthering the geosciences and the understanding of the geologic phenomena in this part of the globe. After the 9th workshop in 1994, the HKT workshop is returning to Nepal, which has been a popular destination for all natural scientists as well as tourists from all over the world alike. The workshop is a forum of all geoscientists for a collegial discussion and for sharing of their new findings from research in the HKT region. The Nepal Geological Society has invited the HKT geosciences community from all over the world to participate and make the event successful.

Convener, co-convener and coordinators of 27th HKT Organizing committee

Dr. Dibya R. Kansakar, Convener
(E-mail: hkt27kath@gmail.com)
Dr. Som Nath Sapkota, Co-convener
(E-mail: somanathsapkota@yahoo.com)
Prof. Dr. Bishal Nath Upreti, Coordinator, Scientific Committee
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Mr. Krishna Prasad Kaphle, Coordinatior, Financial Committee (E-mail: kpkaphle@gmail.com)
Dr. Santa Man Rai, Coordinator, Management Committee
(E-mail: santaman_rai2010@yahoo.com)

Important dates:

November 27, 2012, Tuesday: Pre-Conference field excursion.

November 28, 2012, Wednesday: Inaugural session and beginning of the workshop.

November 29, 2012, Thursday: Continuation of the Workshop, Conference dinner in the evening.

November 30, 2012, Friday: Continuation of the Workshop.

December 1-6, 2012, Saturday to Thursday: Post-conference field excursions (4 different excursions , each of between 1 to 6 days duration)

Important Deadlines:

Workshop pre-registration form submission: End of July, 2012, extended

Abstract submission: July 31, 2012

Workshop and field trip registration and payment (All registrations after this date shall incur a late fee): September 15, 2012

Full paper submission: October 30, 2012

There has been a tremendous interest in this conference from a large number of geoscientists from around the world. Nearly 200 geoscientists from 21 countries have already been pre-registered, and nearly 150 abstracts of the scientific papers have been submitted for Oral and Poster presentations in the workshop.

The Second Circular of the 27th HKT Workshop has already been released.

For further information:

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- Preparing technical session program

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- Arrange and supervise all fooding provisions during the workshop7
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Excursion-5: Kathmandu-Galchhi-Malekhu

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- Prepare a detailed field excursion plan and the cost estimate for the respective excursion routes
- Advise the Organizing Committee and the EC on the breaking-even size of the excursion group
- Prepare excursion handbook and print, if necessary
- Arrange all logistics and conduct the excursion

ARTICLES

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Channel shifting pattern of Manahara River, Kathmandu

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ABASTRACT

River meandering is an inherent characteristic of drainages in an alluvial plain. However, the style and degree of meandering depends on a number of geological factors, including tectonics. Here, we have investigated the Manahara river, a tributary of Bagmati river flowing through alluvial plain. The river follows a slope deviatory course and exhibits a narrow, highly sinuous and moderately incised meandering channel. Several lines of evidence, including satellite and topographic data, stratigraphic and sedimentological data have helped in understanding the controls on the channel morphology of the Manahara river. The study has also revealed that the course of the Manahara river has shifted towards north west in the last 23 years.

BACKGROUND

Rivers in floodplains have the characteristic of meandering freely from one bank to the other and of carrying material which is similar to that of the bed. Materials get eroded constantly from the concave banks and deposits, either between two successive bends to form a bar, or along convex sides of successive bends. Once a stream with an erodible bed and sides, deviates at any point from its linear course, the resulting unbalance of erosive power tends to increase the local deviation and sets a meandering pattern with the original course of its axis. The shape of cross-sections and the slope of the stream are determined by the relative sediment load and the erodability of bed and banks.

The channel pattern of a river depends on its geometry and the processes operating within its reach. Traditionally, the channel pattern of a river has been classified into straight, meandering and braiding types. However, a more recent classification incorporates anabranching (including anastomosing) as a recognizable pattern. The diversity in the channel patterns is caused due to variability of water discharge, sediment load, bedrock outcrops, ground slopes, human activities and tectonic influence. Tectonic movements change the gradient of a river and modify the valley. Alluvial rivers are not significantly affected or constrained by bedrock and flow through sediments that have been eroded and deposited by them or their ancestors.

The migration of meander bends is a characteristic feature of alluvial rivers and one of the most conspicuous changes affecting fluvial landscapes. The proper understanding of meander development and channel pattern changes of alluvial rivers is very important. Meandering is one of the means through which rivers tend towards the so-called dynamic or quasi-equilibrium state.

While recognizing this irregularity and variability, geomorphologists have come to look on channel geometry in general, and meandering patterns in particular, as manifestations of dyanimic equilibrium between hydrologic regime and local geological environment. The degradation process is often accelerated following destruction of the riverbed. Gravel extraction operations is often ineffective of the geomorphological responses outlined above, excessive exploitation may lead to falling water tables, poor water quality and the deterioration of channel and riparian habitats (Brown et al., 1999). Local changes may occur whenever streamflow exceeds the threshold for erosion of the materials composing the banks of the channel, but self-regulatory mechanisms are thought to come into play which tend to restore the overall form of the channel (Langbein and Leopold, 1966). In this approach attention is focused on the assumed equilibrium state and its relationship to prevailing hydrologic and geologic conditions.

STUDY AREA

The Manahara River located in the northeast of Kathmandu Basin is one of the major tributaries of the Bagmati River. The river has high gradient and short headed segment and gentle and long downstream segment. It evolves from the Sheopuri Injection Zone (Ohta,1973) in the north/the Bhimphedi Group of rocks in the northeast, and the basin fill sediments of Kathmandu Basin at southeast.

The Manahara River flows over Kathmandu and Bhaktapur districts (latitude from 27°40'00"N to 27°47'3"N and longitude 85°20'00"E to 85°32'30"E). The total length of the river is 31km, which extends from northeast towards southwest and confluences with the Bagmati River (Fig. 1). The Manahara River also collects several major and minor

tributaries. The major tributaries include the Ghatte Khola, the Sali Nadi, the Satghatte Khola, and the Mahadev Khola.

The Manahara River exhibits sinuous pattern with flood plains along its course. It has deposited clastic sediments (gravel to sand) sourced to surrounding hills and terrace deposits.

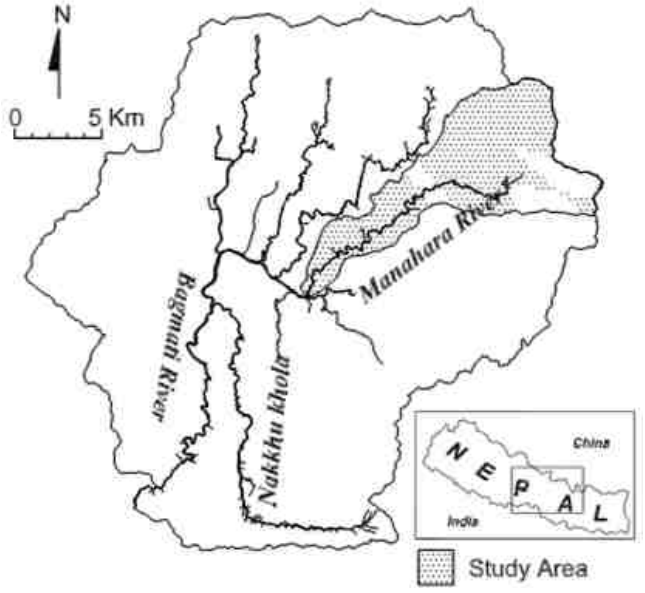

Fig. 1: Location map of study area

R. K. Bajracharya (2001) studied geology of Bhaktapur-Nagarkot area and concluded that the river channel of the Manahara River was evolved or shifted westward due to neotectonics in this basin.

The sediments of the Manahara River have been exploited for construction material from last few decades. Therefore, many banks and channel segments have been altered remarkably. The flood plain and point bars of this river are being used for settlement and cultivation from historic time, but from the last few decades flood plain encroachment rate is being high causing instabilities and channel degradation. Clearance of natural buffer zone from catchments for agriculture and urban development is also in increasing rate, which triggered soil erosion and landslides. Disposal of sewage, solid waste and chemical waste from nearby settlement areas and industries in to this river cause pollution in river.

Studying present status of riverbank, erosion processes and bank erosion potential are important for elucidation lateral channel instability and bank erodibility hazard along the Manahara River. To find out cause of bank erodibility, lateral channel instabilities and bank erosion along this Manahara River is very important to preserve many historic and aesthetic sites located around this river, such as the UNESCO World Heritage Sites; the Changunarayan Temple, and International Airport (UNESCO 2000). And another historic important temples the Salinadi Temple and Nilbarahi Temple located at the uphill side of Manahara River, is suffering from landslide problem triggered by sand mining on the river.

STATEMENT OF PROBLEMS

Since, the river bank of Manahara River covers all the fertile land and settlements areas. The typical problems which are normally encountered in river management are those arising out of natural causes or those caused by manmade structures or encroachments into the river bed. By finding the shifting pattern can prevent the future loss on agricultural field and humans living in the bank side area.

MATERIAL AND METHOD

Four years river patterns (1989, 1995, 2001 and 2012) were gathered with help of Landsat imageries and GeoEye. The pattern was compared by using GIS software. After that four maximum shifted place were selected randomly in accordance to the map by seeing drastically shifted locations. After that all the four years map were compared to see the maximum length of shifting.

The satellite imagery of the Manahara river shows a number of meander loops and cut-offs forming the so called ox-bow lakes. Analysis of the satellite data also shows a convexity in the abandoned loops towards the west, indicating that the channel of the Manahara river has shifted towards the northwest.

A method originally devised by Langbein and Leopold (1966), is useful for analyzing the meander pattern of highly sinuous rivers. In this technique, relative positions of the streams on different dates are matched. The position of the meander loop is approximated by the position of its centroid, which is the point midway on its axis. Relative shift of the stream centroid on these two dates is obtained and the movement of the loop was approximately found by the distance and direction that its centroid shifted from time 1 to time 2. The orientation of the loops was measured from the north and the distance and direction of the shifting of the centroid from time 1 to time 2 are shown in Fig. 2. The centroids from time 1 to time 2 have moved from 32 to 330 m indicating a major shift of the meander loops towards the northeast in last 23 years in this sector. However, the orientations of the meander loops suggest that the general tendency of the river is to shift towards the east.

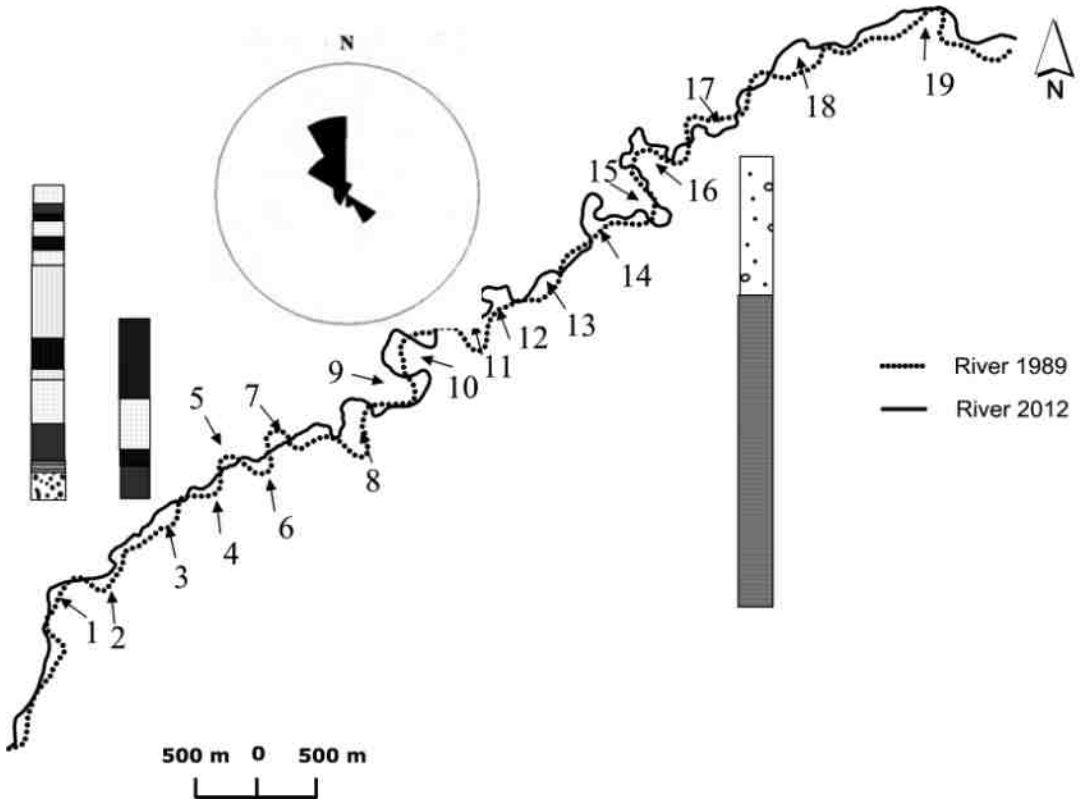

Fig. 2: Representation of river shifting pattern

SHIFTING PATTERN

From the maps that were taken in account shows that the river was shifted mainly to NNW direction and little to SEE direction. The angle of shifting was shown by the rose diagram in accordance to 1989, 1995, 2001 and 2012 river pattern.

The river has been suffered from severe bank erosion hazard from earlier time. The bank erosion hazards occurring along the Manahara River corridor is triggered by several anthropogenic disturbances, and besides these natural and geologic factors is also responsible for causing bank erosion and lateral instability. Mining of construction material from channel and banks of river is adversely impacting the river environment. Such activity has altered the natural balance of river system as well as has influenced the river dynamic equilibrium system also. Major causes of such river instability in the study area as identified are rapid landuse change, vegetation clearance, meander migration, unconsolidated bank material, removal of sediment from stream bed and bank, etc.

The channel length of the river during 2012 has found to be 19.152 km and valley length is 12.155 km. From this the sinuosity index was calculated to be 1.576. While of 1989 the channel length was 18.297 km and valley length was found to be 14.392 km. Sinuosity index of the river was 1.271. From this we can say that the river length was increasing due to lateral shifting which means there is maximum erosion.

The shifting length has been increased tremendously from the year 1989 to 2012. The maximum shifting was found to be approximately 330 m to the north east direction in account to 1989 as shown in Fig. 2.

IMPACT OF RIVER SHIFTING

Bank caving is one of the main causes of river instability and therefore degrades the agricultural land resulting decreases in crop yield and huge economic crisis to the local farmers. Therefore, bank protection especially of the pitching type forms an important part of training works. Generally, there is a tendency of meanders either to shift progressively downstream or cutoffs. The process of bank erosion is therefore, constantly active and river training for protection of banks continues to be recurring problem. River training in its broad aspects covers all engineering works constructed on a river to guide and confine the flow to the river channel

and to control and regulate the river bed configuration for effective and safe movement of floods and river sediment.

CONCLUSIONS

Hence, from the study it was taken out that the river has been generally shifted to the NNW and SSE direction. The river bank consist of coarse sand and fine sand with little bit of clay, silt and gravels. The nature of soil on the agricultural land mostly consists of black clay with silt and sand. So, the land seems very fertile. The migration of meander is a characteristic feature of rivers and one of the most conspicuous changes affecting fluvial landscapes. From the year 1989 to 2012 the migration of the Manahara River is in increasing order. The maximum length of lateral shifting of the river at the study site is about 330 m during 23 years period (i.e. 1989-2012). The sinuosity index of the river in 1989 was found to be 1.271 and 2012 was found to be 1.576. The river length was increasing due to lateral shifting.

The lateral movement devastates the good cultivated area resulting the huge economic loss to the local farmers. The illegal encroachment of river bank and excessive taking out of sand from the river bed has speeded up the vertical erosion of the channel, affecting existing bridges. The Manahara low lying area is likely to be affected by floods as they are prone to flood hazards. Hence, these areas are not suitable for human settlements but can be utilized for agricultural fields. A risk of flash flood can always be a threat in these in future. River cutting is another threat that needs to be taken care. Lowland area that gets flooded during heavy rain is covered with sediment deposited by streams decreasing the soil fertility of khet and bari land. Overall, soil erosion is the most important reason for declining the soil fertility on these lands. The low land areas are suitable for both dry and wet cultivation only with the proper river training works but not for the construction of buildings. Understanding the linkages between environmental change and fluvial process is becoming increasingly important in the last decades of the 20th century. The effects on river channels have followed from changes of drainage basin characteristics because alterations in land use such as afforestation, clearing of woodland, agricultural land development and urbanization, occasion changes in runoff and sediment production that in turn can affect the river channel and induce change.

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Neogene pollen assemblage from the Thakkhola-Mustang Graben, central Nepal Himalaya

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ABSTRACT

The Thakkhola-Mustang Graben lies north of the Dhaulagiri-Annapurna ranges and south of the Yarlung-Tsangpo Suture Zone. The basement of Thakkhola-Mustang Graben is composed of Tibetan-Tethyan sedimentary rocks of Paleozoic and Mesozoic ages, which are unconformably overlain by continental debris of Neogene to Quaternary age. Stratigraphically, the Thakkhola-Mustang Graben sediments have been divided into five formations namely the Tetang Formation, the Thakkhola Formation, the Sammargaon Formation, the Marpha Formation and the Kaligandaki Formation. Detailed palynological studies were carried out to understand the paleoclimate. Lacustrine layers in the Tetang and Thakkhola formations are enriched with pollen. Pollen analysis shows that the sediments contain dominant alpine trees *Abies, Pinus, Keteleeria, Picea Tsuga* and *Quercus* with some steppe elements such as *Artemisia,* Compositae, Chenopodiaceae*, Plantago* and Poaceae. The results show that during this period, the southern part of Tibet was covered mainly by steppe vegetation, indicating dry climate.

INTRODUCTION

The north-south trending Thakkhola-Mustang Graben is located in the Tibetan-Tethys Zone of central Nepal between 83˚50"-84˚ east longitudes and 29˚-28˚50" north latitudes bounded by South Tibetan Detachment Fault System (STDS) (Burchfiel et al. 1992) to the south and Indus-Tsangpo Suture Zone (ITSZ) to the north. This graben is a part of normal faulting system affecting the whole Tibetan Plateau (Molnar and Tapponnier 1978). The basement rock of the graben is consisting of a thick and nearly continuous lower Paleozoic to lower Tertiary marine sedimentary succession.

The basement rocks of Paleozoic to Mesozoic ages unconformably overlain by Neogene to Quaternary age sediments (Fort et al. 1982; Yoshida et al. 1984). These Neogene deposits have been divided in to five formations: the Tetang Formation, the Thakkhola Formation, the Sammargaon Formation, the Marpha Formation and the Kaligandaki Formation. Older Miocene Tetang and Thakkhola formations are disconformably overlained by upper Pliocene to upper Pleistocene Sammargaon and Marpha formations, respectively (Fig.1B). The Holocene Kaligandaki Formation is in a cut-and-fill relation with these older formations. The two older Thakkhola and Tetang formations lie unconformably on a substratum of the high strain rocks of the deformed Tibetan-Tethys sedimentary sequences and they are separated by a low angle (~5°) unconformity (Fort et al. 1982; Adhikari and Wagreich 2011 a,b).

In this paper, we report the palynological content of samples from a succession of the Tetang and Thakkhola formations. The data are discussed in the context of paleoenvironmental evolution of the southern margin of Tibet.

METHODOLOGY

Twenty-six samples were collected from the black to grey clay beds of the Tetang and Thakkhola formations. The samples were prepared in the laboratory following the methods described by Zetter (1989), and Ferguson at al. (2007). In order to remove any contamination from the recent pollen from the atmosphere the samples were cleaned with scrapper, crushed them to powder and treated with Hydrochloric acid (HCl) to remove any carbonate contain in it. This was followed by the treatment with Hydrofluoric acid (HF) and boiled for half an hour to remove silicate minerals from the samples. The samples were then forwarded to chlorination and acetolysis a then washed with distilled water and glacial acetic acid in each step and centrifuged at the rate of 2000 rpm for 2-3 minutes to remove the finer fraction of the sediments from the sample. Finally the organic material was separated from the inorganic residue using heavy liquid Zinc Chloride ($ZnCl_2$). The residue thus obtained was washed several times with distilled water and mixed with glycerin for microscopic observation. In general, the state of preservation of the polynomorphs was very poor.

RESULTS

More than 19 families and genera of pollen were identified from all of the samples (Table 1). A high percentage of

grassland taxa and a low percentage of temperate forest taxa characterize the pollen assemblages. One sample from Tetang village of the Tetang Formation and one sample from the Tange Village of the Thakkhola Formation contain more pollen compared to other samples.

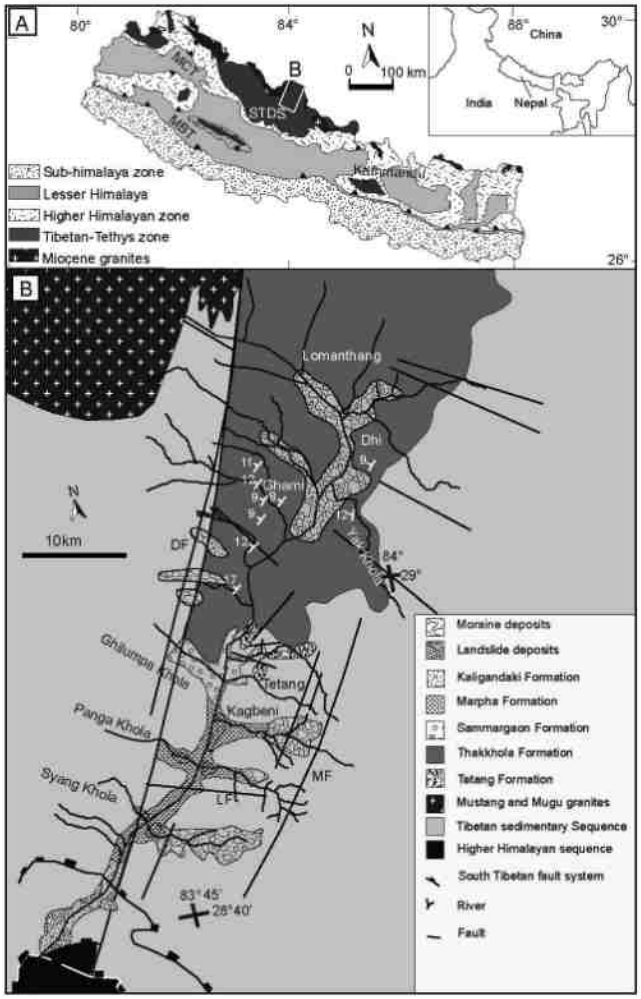

Fig.1: Location map of the Thakkhola-Mustang Graben (Adhikari and Wagreich 2011a). A) Regional geological map of the Nepal Himalaya B) Geological map of the Thakkhola-Mustang Graben showing the graben fill units. The location B is shown in Fig. A

Seven samples out of seventeen samples collected from the Tetang Formation at Tetang village contain pollen. All samples were carbonaceous clay with plant fossils in some samples. Sediments display a higher percentage of *Pinus*, *Quercus* and *Keteleeria* with *Abies* and *Tsuga* and low concentration of *Betula* and *Juglans* (Plate I, II and III). The upper horizon of the Tetang Formation is dominantly lacustrine sediments, which are rich in pollen.

Similarly, only five samples out of nine contain pollens in the Thakkhola Formation. Sample collected from the Chaile section and Tange sections are rich of pollen and spores. Sample taken from the Chaile section is characterized by a presence of Angiosperms and Gymnosperms pollen. *Pinus, Quercus, Tsuga, Fagus, Juglans, Betula, Tilia, Salix, Acer, Fraxinus* and *Plantago* are the dominant pollen grains. Pteridophyte spores are found in the sample taken from Tange section. Lycopodiaceae, Polypodiaceae and Pteridaceae families dominate these spores. Most dominant pollen grains are *Pinus, Quercus, Plantago, Poaceae,* Compositae and *Artimisia* in the Tange section *(Plate I, II & III)*.

Table no. 1: Neogene pollen assemblage of the Thakkhola-Mustang Graben

Phylum	Family	Genus	Fig. No.
Pteridophytes	LYCOPODIACEAE	*Lycopodiaceae*	1
	POLYPODIACEAE	*Polypodium*	2
	PTERIDACEAE	*Pteris*	3
	Family indetermined		4
Gymnosperms	PINACEAE	*Abies*	5
		Keteleeria	6
		Picea	7
		Pinus	8
		Tsuga	9
Angiosperms	FAGACEAE	*Quercus*	10
		Fagus	11
		Fagaceae ?	12
	JUGLANDACEAE	*Juglans* .	13
	BETULACEAE	*Alnus*	14
		Betula	15
	TILIACEAE	*Tilia*	16
	SALICACEAE	*Salix*	17
	ACERACEAE	*Acer*	18
	OLEACEAE	*Fraxinus*	19
		Ligustrum	20
	CARYOPHYLLACEAE	Caryophyllaceae gen. indet.	21
	ROSACEAE	Rosaceae gen. indet.	22
	VITACEAE	*Parthenocissus*	23
		Vitaceae	24
	CHENOPODIACEAE	Chenopodiaceae gen. indet.	25
	PLANTAGINACEAE	Plantago	26
	POACEAE	Poaceae gen. indet.	27
	COMPOSITAE	Tubiflorae Compositae gen. indet.	28
	ASTERACEAE	*Artemisia*	29
		Undetermined	30

DISCUSSIONS

The pollen assemblage include arboreal taxa (such as *Pinus, Betula, Keteleeria, Juglans, and Quercus*), shrub taxa (such as Oleaceae) and herbaceous taxa, which are mainly Chenopodiaceae, *Artemisia*, Poaceae and Rosaceae. The palynofloras of the Thakkhola and Tetang formations may reveal that paleotemperature is the key factor in controlling long-term trend and fluctuations in Neogene vegetation in Thakkhola-Mustang Graben. *Pinus* is usually over-represented because of its high pollen production and long distance dispersion (Denton and Karlen 1973; Wang and Wang 1983) and the percentage of *Pinus* below 10% are insignificant (Faegri and Iverson 1989). Therefore, they are generally regarded as being exotic. Presence of *Keteleeria* in Tetang Formation may indicate the warm climate but it can be reworked from the older sediments. Yoshida et al. (1984) suggested the dry climate during the deposition of Tetang Formation based on the high percentage of *Ephedra* spores.

Betula, Quercus and *Juglans* are very sensitive to humidity and their pollen contents increase with rainfall (Sun et al. 1996). Therefore, presence of these taxa in Thakkhola-Mustang Graben indicates temperate forest increased significantly, implying a relatively humid climate. Presence of high percentage of *Plantago*, Poaceae, *Artimisia* and Chenopodiaceae in Thakkhola Formation indicate the arid climate. They show that mostly steppe vegetation was dominant during the deposition time of Thakkhola Formation. This steppe vegetation might caused by the Himalayan barrier. The uplift of the Tibetan Plateau could exert a profound effect upon atmospheric circulation and environmental changes of Asia. It would form a water vapor barrier, so that the water vapor carried by the south-west monsoon could not reach the Tibetan Plateau (Ruddiman and Kurzbach 1989), leading to the decrease of rainfall and gradual vegetation change to arid grasslands in the Thakkhola-Mustang Graben.

CONCLUSIONS

Graben sediments are composed of braided fluvial deposits with lacustrine deposits in different level of the succession. Lacustrine layers in the Tetang and Thakkhola formations are enriched with pollen. Pollen analysis shows that the sediments contain dominant alpine trees *Abies, Pinus, Keteleeria, Picea Tsuga* and *Quercus* with some steppe elements such as *Artemisia, Compositae, Chenopodiaceae, Plantago* and *Poaceae*. The results show that during this period, the southern part of Tibet was covered mainly by steppe vegetation, indicating dry climate. It is presumed that the paleoclimate during the sediment deposition time of the Thakkhola-Mustang Graben was significantly warmer than the present-day climate.

ACKNOWLEDGEMENTS

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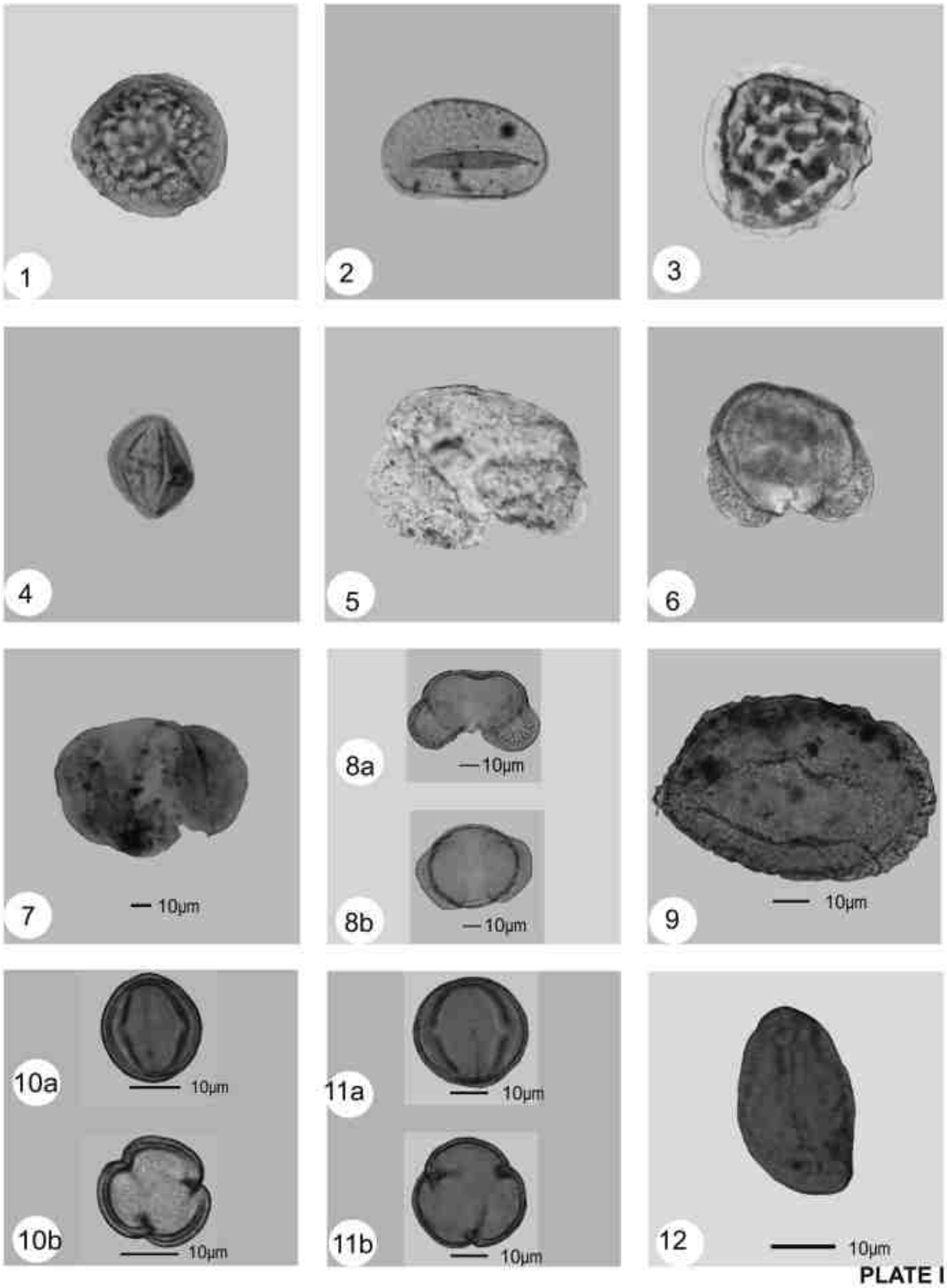

PLATE I

EXPLANATION OF PLATE

1. Lycopodiaceae, LM X 200, 2. Polypodiaceae, LM X 200, 3. Pteris sp., LM X 200 4. Fam. indet., LM X 200, 5 . Abies sp. LM X 200, 6. Keteleeria sp. LM X 200, 7. Picea sp., Equatorial view, LM X 200, 8a. Pinus sp., Equatorial view, LM X 600, 8b. Pinus sp., Polar view, LM X 600, 9. Tsuga sp., Polar view, LM X 600, 10a. Quercus sp., Equatorial view, LM X 600, 10b. Quercus sp., Polar view, LM X 600, 11a. Fagus sp., Equatorial view, LM X 600, 11b. Fagus sp., Polar view, LM X 600, 12. Fagaceae (?), Equatorial view, LM X 600

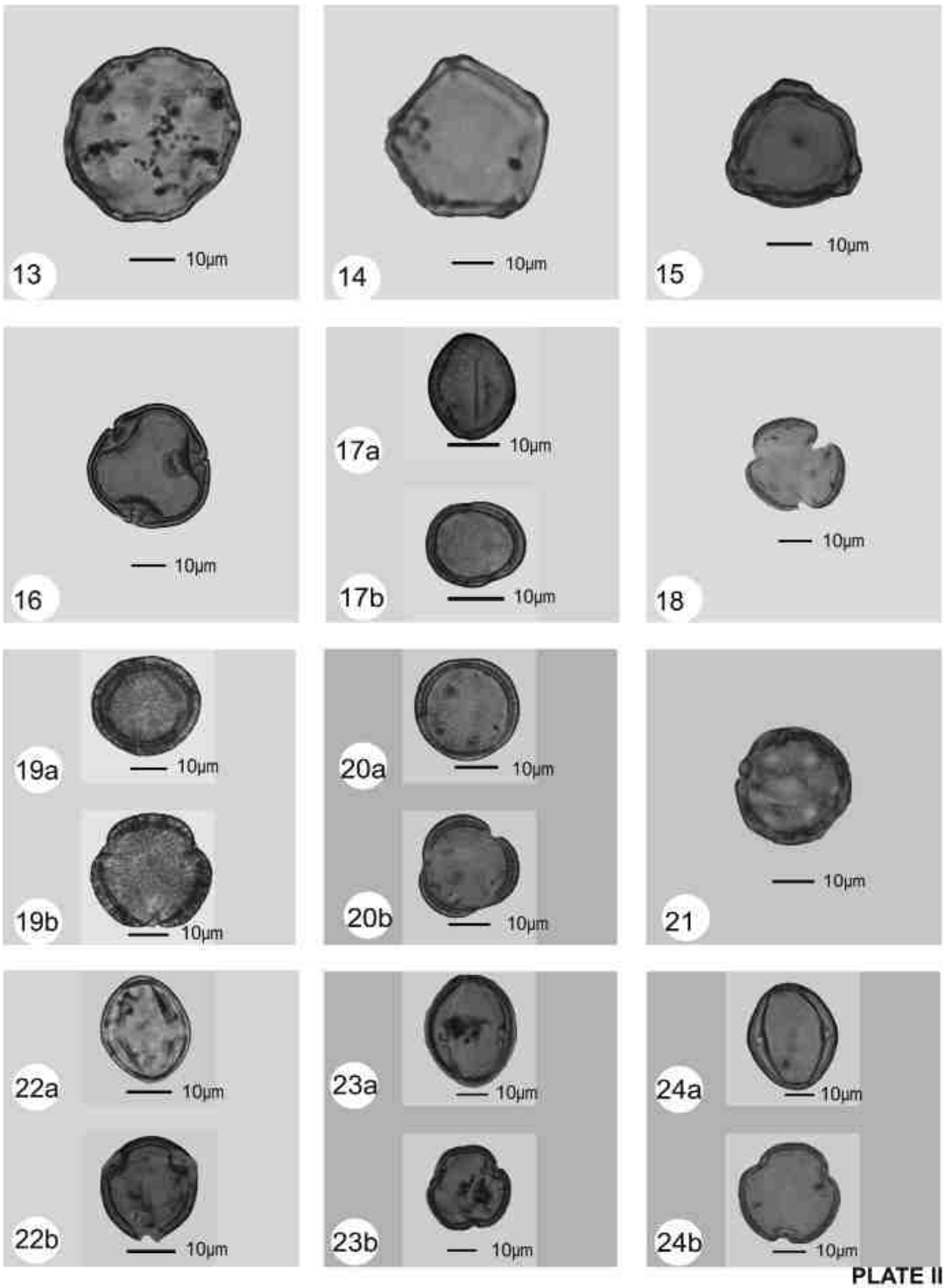

PLATE II

EXPLANATION OF PLATE

13. Juglans sp., LM X 600, 14. Alnus.sp., Polar view, LM X 600 , 15 . Betula sp., Polar view, LM X 600, 16. Tilia sp., Polar view, LM X 600 , 17. Salix sp., Equatorial view, LM X 600, 18. Acer sp., Polar view, LM X 600, 19a. Oleaceae (Fraxinus), Equatorial view, LM X 600, 19b. Oleaceae, Polar view, LM X 600, 20a. Oleaceae (Ligustrum), Equatorial view, LM X 600, 20b. Oleaceae, Polar view, LM X 600, 21. Caryophyllaceae, LM X 600, 22a. Rosaceae, Equatorial view, LM X 600, 22b. Rosaceae, Polar view, LM X 600, 23a. Parthenocissus sp., Equatorial view, LM X 600, 23b. Parthenocissus sp., Polar view, LM X 600, 24a. Vitaceae (?), Equatorial view, LM X 600, 24b. Vitaceae (?), Polar view, LM X 600

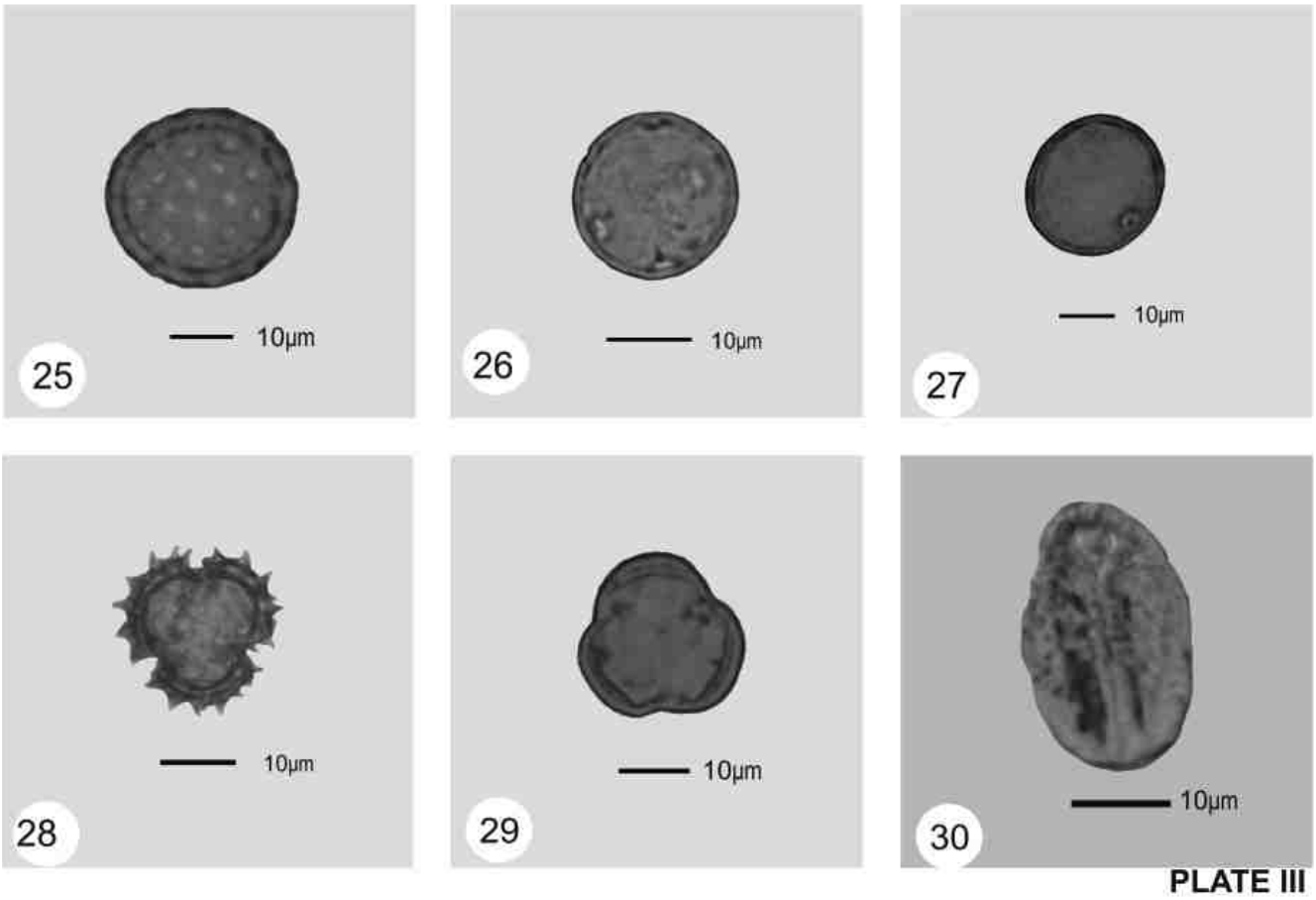

PLATE III

EXPLANATION OF PLATE

25 . Chenopodiaceae, LM X 600, 26. Plantago sp., LM X 600, 27. Poaceae, LM X 600, 28. Compositae, Polar view, LM X 600, 29. Artemisia sp., LM X 600, 30. Unidentified, Polar view, LM X 600

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Tree-ring from central Nepal: Indicator of south Asian paleo-drought

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Himalayan birch (*Betula utilis* D Don) is a long-lived, broadleaf tree species native to the Himalayas mainly found in Afghanistan, Pakistan, India, Bhutan, Nepal,Northen and western China. However, it has received limited attention for dendroclimatological studies. Based on 49 tree-ring cores from 41 Himalayan birch trees at two sites in the Langtang National Park, Central Nepal, a 458-year long chronology (back to AD 1552) was developed. To date, it is the longest for this species in the Himalayas.

The tree-ring width chronology of Himalayan birch could be taken as a indicator of the mega-drought in central Nepal. However, instrumental records from most meteorological stations are available after the 1960s and no other long-term precipitation proxies in Nepal could be used to validate drought events derived from tree rings. As observed with instrumental records, large-scale droughts after 1960 occurred in 1965, 1967-1973 and 1999-2001 in Nepal (Sigdel and Ikeda 2010). In these years, Himalayan birch showed extreme narrow tree rings, confirming that its growth is a reliable indicator of drought. In particular, extreme droughts in March-April in 1999 and March-May in 2000 corresponded to a high frequency of missing rings (65% and 35%, respectively) of both years at the site close to Langtang village. The drought events around the 1810s and 1950s were observed in other tree-ring based precipitation reconstructions in the western Himalayas (Singh et al. 2009; Yadav 2011) and the snow accumulation record from the Dasuopu ice core (Yao et al. 2000; Duan et al. 2004). The well-documented historical megadroughts, such as the Strange Parallels drought (1756-1768), the East India drought (1790-1796) and the late Victorian-era Great Drought (1876-1878) (Cook et al. 2010), appeared to be embedded in much longer drought periods in our series. In this context, the persistent pre-monsoon droughts in the central Himalayas seem to be harbingers of the megadroughts induced by the South Asian monsoon failure.

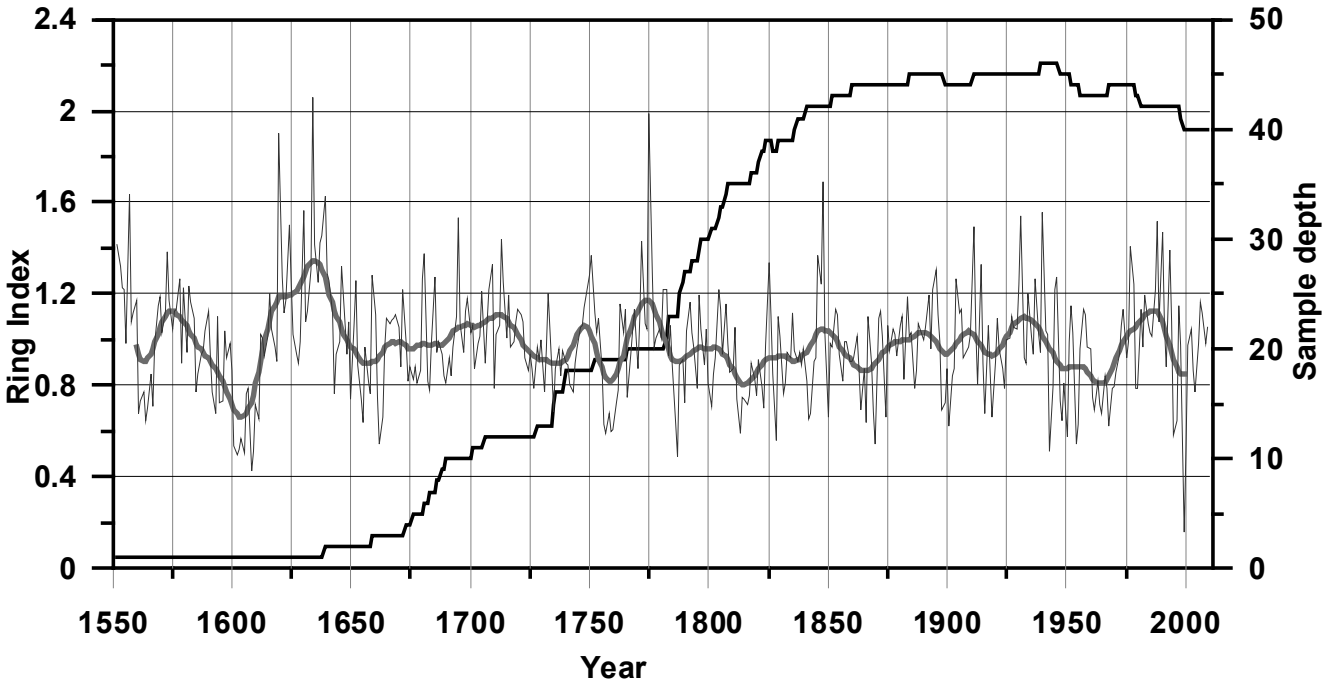

Fig. 1: Tree ring chronology with 11 year moving average curve and sample depth

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Geological features and history of Mount Fuji, Japan: An overview

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ABSTRACT

Japan is one of the most noted volcanic countries in the world where approximately 10 % of the world's land volcanoes exist and 108 of them are active. Drawn from a combination of field observations and literature review, the present study provides a general overview of the geological features and history of Mount Fuji, the highest mountain (3,776 m) of Japan. Mt. Fuji is a large composite stratovolcano, which measures ca. 50 km across the base and ca. 153 km in circumference. It has gracefully curving symmetrical flanks and a circular summit crater ca. 500 m across and 250 m deep below the highest point. Volcanic activities in the Mt. Fuji area started ca. 200-700 ka ago and the last eruption of AD 1707-08 created the present shape and dimension of the mountain. It was regarded as a dormant volcano, but the perception has changed since the occurrence of swarms of low-frequency earthquakes beneath the mountain in 2000 and 2001. If Mt. Fuji were to erupt like it did before, the damage in the surrounding area could be devastating because population around the mountain is much higher than any time in the past.

INTRODUCTION

Mount Fuji (35º21' N, 138º43' E), the volcanic and the highest mountain (3,776 m) of Japan, is located about 110 km west of Tokyo in southern Honshu Island (Fig. 1). Its superb height and volume, eminent snow capped peak, and symmetrical beauty of flank lines (Fig. 2) has become a symbol of Japan. Topographic depression on the northern foot of Mt. Fuji hosts a series of five fresh water bodies, viz. Lake Yamanaka, Lake Kawaguchi, Lake Sai, Lake Shoji, and Lake Motosu (Fig. 1), which are popularly known as Fuji-Five Lakes. During 1707-08 eruptions, even the Tokyo area experienced >6 cm thick ash fall deposits (Miyaji 2002). Besides its beauty and geological importance, the mountain has become a cultural icon to the people of Japan, and its images are held in high regard.

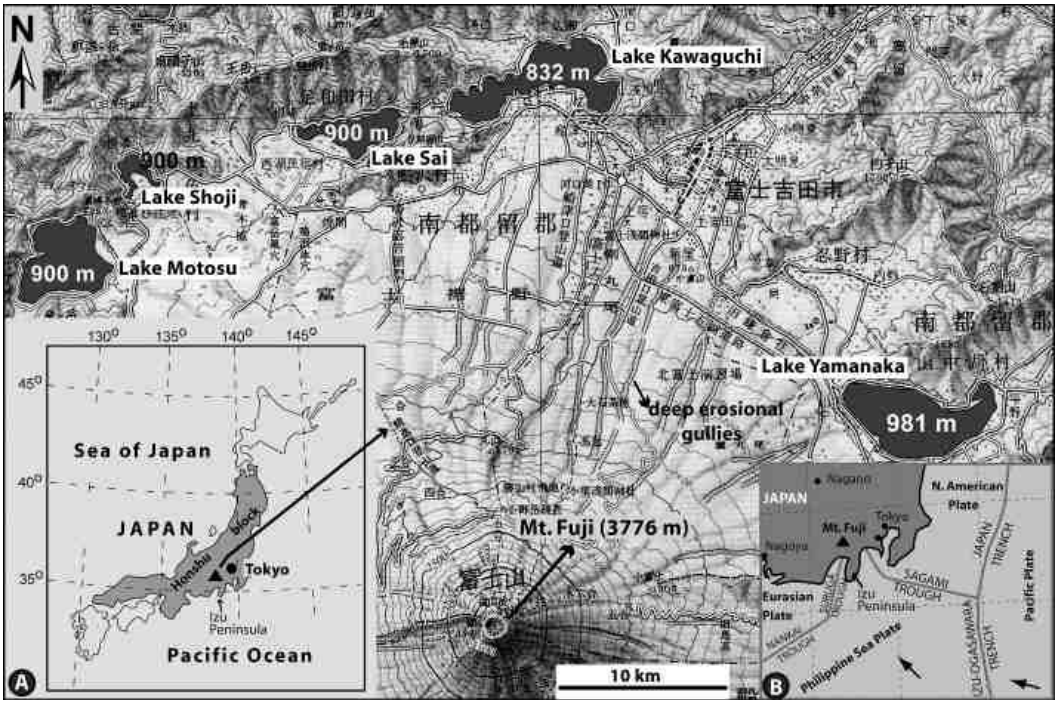

Fig. 1: Location of Mount Fuji and the Fuji-Five Lakes, Japan and the tectonic setting of the region (inset B). Topographic contours are at 100 m intervals (adopted from the topographic map, Geographical Survey Institute of Japan, Fuji-San, 1:25,000)

Fig. 2: The winter view of Mt. Fuji from Lake Kawaguchi located in the northern foot of the mountain. Reflection of the mountain is seen on the lake

There are many volcanoes in Japanese Archipelago, where approximately 10 % of the world's land volcanoes are said to exist (Fujita 2009). Japan is home to 108 of the world's 1,500 active volcanoes. The basic cause of active volcanic activities around Japan is the subduction of the Pacific Plate or the Phillipine Sea Plate under the Eurasian Plate (Figs. 1 inset B and Fig. 3).

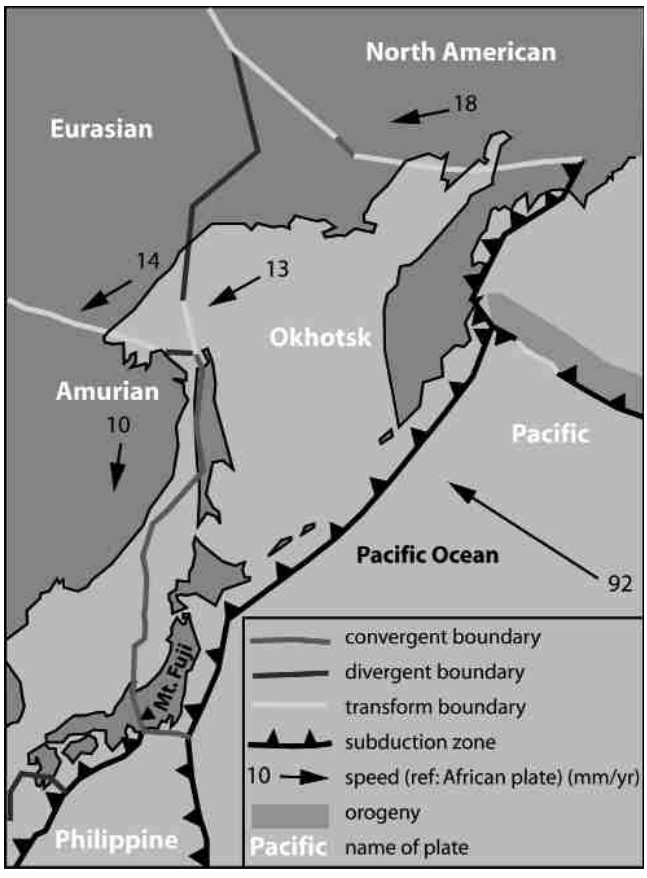

Fig. 3: Map of the tectonic plates around the Japanese Archipelago (source: en.wikipedia.org)

The objective of this paper is to give a general overview of the geological features and history of Mt. Fuji to help readers understand how this world famous volcanic mountain looks like from geological point of view. In addition to the author's experience in the Fuji-Five Lakes area during 2003-2005, the information presented in this study are drawn from literature sources.

GENERAL FEATURES

Mt. Fuji measures about 50 km across the base and about 153 km in circumference. It has gracefully curving slopes (Fig. 2) diminishing from 32° near the summit to 25-27° in the middle to almost level at the base (Tsuya 1971). Its body surface area is about 960 km^2 and volume about 1,400 km^3 (1/140 of Mauna Loa, Hawaii). The mountain summit is 500 m across the circular crater while the crater is 250 m deep from the peak (3,776 m). The upper half of the mountain is all in white color in winter (Fig. 2). Shady slopes in and around the summit crater remains covered by small patches of permanent icy snow even in midsummer. But any traces of past glaciations are found nowhere on the mountain (Tsuya 1971).

The flanks of the mountain are covered with vegetation up to the height of about 2,500 m. The tree line is reported to have moved up due to contemporary climate warming. The common trees in the lower slopes include pine and rhododendron species. The apical part above 3,000 m is virtually barren, forming steep slopes and bluffs covered either with lava flows or with pyroclastic deposits.

In Mt. Fuji area, the flanks and the lower mountain slopes are sculptured by a number of radial valleys and erosional gullies (Fig. 1), none of which has usual surface stream except during occasional torrential rain events in summer and typhoon seasons and sudden snow melt in spring (Tsuya 1971). The lack of surface streams is due to the fact that the pyroclastics and the lavas on the surface are highly permeable and water on the surface easily percolates through the porous media. Below the porous materials, the mudflows and pyroclastic deposits are impermeable and the percolating water could not move further deep, instead it is stored as groundwater, and appears, at the foot of Mt. Fuji, as springs or waterfalls along the boundary between the porous and nonporous materials (Koshimizu and Tomura 2000). Surface erosion in the area due to running water is not high as large quantity of temporary torrential rain sinks into the porous ground.

Ancient Japanese people revered the nearly perfectly symmetrical Mt. Fuji (Fig. 2) as sacred, and it is a shrine to the followers of the Shinto and Buddhist faiths. For centuries, only the holy men and male followers were permitted to climb the mountain for the associated spiritual experience. However, after the Shogun (hereditary military dictators from 1192 to 1867) were defeated, the mountain was opened to all who wished to climb it. Since then several quotes regarding the mountain have surfaced, such as "If you

never climb Mt. Fuji, you are a fool, but if you climb it more than once you are also a fool" and "Fuji-san is a mountain for looking at, not for climbing" etc.

GEOLOGICAL HISTORY OF FUJI VOLCANO

Mt. Fuji is a large composite stratovolcano. It is the largest volcano in Japan, and the younger part of the volcano is made primarily of basalt, which is somewhat unusual as stratovolcanoes in other parts of the Japanese Islands are of andesite or dacite in composition (Tsuya 1971). The Mountain is composed of four superposed cones, Sen-Komitake Volcano, Komitake Volcano (KV), Ko-Fuji or Older Fuji Volcano (OFV), and Shin-Fuji or Younger Fuji Volcano (YFV) (Fig. 4) in the order of decreasing age (Miyaji et al. 1992). The Sen-Komitake is known to have formed several hundred thousand years ago (before Komitake) and composed of Andesite (Miyaji 2002). Recent borehole data revealed that the basement rocks beneath the volcano belongs to the Tertiary marine sediments (http://www.city.fujiyoshida.yamanashi.jp/div/bosai/html/hazard_map/index.html). The three volcanoes, erupted after Sen-Komitake, are described below.

Komitake Volcano

In middle Pleistocene (~200-700 ka ago), at the current location of Mt. Fuji, a volcano known as Mt. Komitake became active (Miyaji et al. 1992). Around this time, another volcano, Mt. Ashitaka, in the nearby area to the southeast of Mt. Fuji (Fig. 4), was also highly active. The peak of the ancient volcano, Komitake, can be seen in the northern slope of Mt. Fuji as a prominent shoulder of mountain at the fifth station (the terminal parking lot of the highway called 'Subaru Line"), about 2,300 meters above sea level (Fig. 2).

The Komitake Volcano is considered as the remnant of a giant stratified cone composed of many lava sheets, together with interstratified agglomerate and other pyroclastic materials (Tsuya 1971). The lavas of this volcano are olivine-bearing two pyroxene-andesite, and its petrographic and chemical analysis shows close resemblance to Ashitaka Volcano, but differs clearly from the composition of the rocks in the main body of the volcano.

Although the volcano is recognizable only as a shoulder on the mid-slope of Mt. Fuji at present, it is actually a large volcano rising higher than 2,400 m above sea level, and prior to the birth of the Fuji volcano, it stood separately on the north of the Ashitaka volcano, vying with the latter in height. Therefore, it is possible that, beneath Mt. Fuji, the ejecta of Komitake are interfingered to some extent with those of Ashitakayama, if their opposite flanks extend far down to join with each other (Miyaji et al. 1992). Since the activity of Komitake Volcano ceased growing a long time ago, it is often not considered as a part of the Fuji volcano. The present features of Mt. Fuji are hence geologically divided into two sequences, OFV and YFV.

Older Fuji Volcano

The Older Fuji Volcano (OFV) remained active during 100,000 -11,000 years ago (Miyaji 2002). The volcano in this period is known to have explosive eruptions, throwing out large quantities of scoria, volcanic ash, and lava, forming a large mountain in the southern side of Mt. Komitake (Fig. 4) which reached a height of 3,100 m. Its activity was characterized by the ejection of voluminous pyroclastic falls and large scale mudflows (Older Fuji mudflows). Total volume of the ejecta is estimated at 250 km^3 (Miyaji et al. 1992).

Younger Fuji Volcano

The Younger Fuji Volcano (YFV), the present day Mt. Fuji (Fig. 4), started its activity about 11,000 years ago. Miyaji et al. (1992), based on tephrostratigraphy and ^{14}C age determination, subdivided the eruptive history of YFV in six different stages, which are characterized by eruptions of different types and natures, such as summit crater eruptions, summit and flank-fissure eruptions, major lava flows and minor pyroclastic falls. The total volume of all erupted products in the Younger Fuji period is estimated to be 47 km^3, 83 % of which erupted during 11- 8 ka ago.

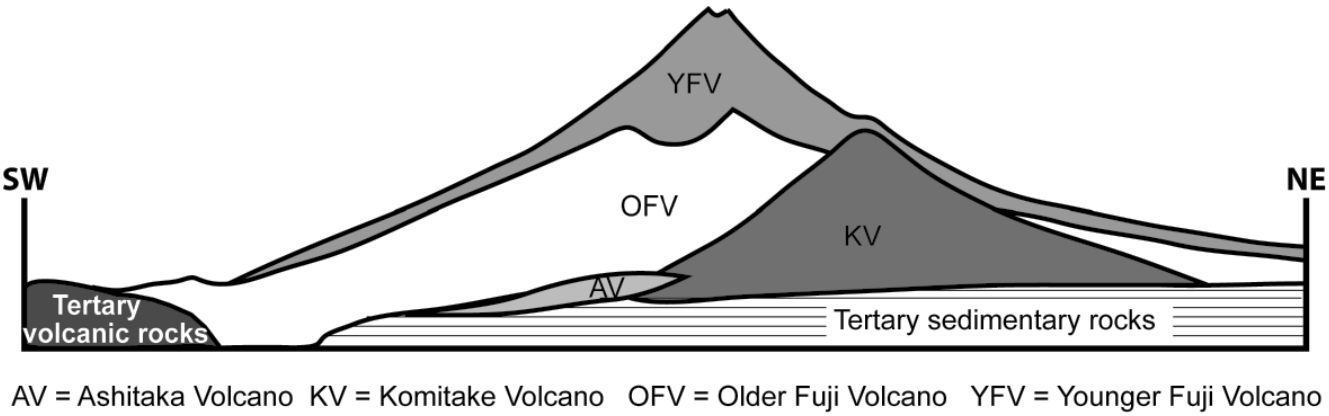

Fig. 4: Schematic cross-section of the Fuji volcano (Modified after Miyaji et al.1992)

Most of the volcanic materials on the surface around Mt. Fuji are composed of the YFV, whereas materials from OFV are covered by the thick deposits of the YFV. Within the past 11,000 years, it has erupted more than 75 times, and 50 tephra deposits now recognizable as distinct horizons are intercalated in the sediments of Lake Yamanaka (Adhikari 2011; Koshimizu and Uchiyama 2002).

In most localities, the scoria-fall deposit is composed of massive bed of lapilli with a reddish-brown color. The tephra clasts are dominantly angular to subangular and display a wide range in vesicularity from frothy scoria to dense, fresh fragments with few vesicles (Fig. 5a). The clasts are composed mostly of vesicular glass; pale clasts are called pumice and darker ones scoria. Some clasts are only moderately vesicular and have higher specific gravity. Composition of Mt. Fuji tephra ranges from andisitic to basaltic (Miyaji 2002). Most pumice is andisitic or basaltic, and all the scoria is andesitic or basaltic.

(a)

(b)

Fig. 5: (a) Scoria fallout deposit. (b) Volcanic bomb ejected by the Younger Fuji Volcano

The color of the tephra varies between light reddish and dark-gray. Volcanic bombs of different shape and size strewn about on the surface can be seen near the summit crater (Fig. 5b). Mt. Fuji has experienced more than 18 major historical eruptions since AD 781 (Tsuya 1971), many of them occurred between 800 and 1083. Sometimes inactive periods between eruptions lasted for hundreds of years (Tsuya 1971). It has not erupted since the 1707-08 Hoei eruption.

Mt. Fuji has a larger eruption rate than the most of other island-arc volcanoes by one order of magnitude (Fujii 2001). It has erupted mostly basaltic products, although it is an island-arc type volcano (Tsuya 1971). These features may be due to the unique tectonic setting of Mt. Fuji, which is located near three converging plates, the Eurasia, North American, and Philippine Sea Plates [Figs. 1 (insets A, B) and 3)]. The region around Mt. Fuji is a zone of crustal collision where the Izu block (Izu Peninsula) collides with the Honshu block pushing it towards NW direction. More than half of the parasitic craters of Mt. Fuji are located on the NW and SE flanks of Mt. Fuji (Fig. 6), and are manifested by numerous magmatic-dikes running parallel in the NW-SE direction (Tsuya 1971). This direction is strongly related and has influenced to regional stress field (Nakamura 1977). There are some 60 parasitic cones, and about one-third of them formed during 4500-3000 BP.

Hoei eruption

The last eruption, a Plinian type in nature and known as Hoei eruption, started on December 16, 1707 and ended on January 1, 1708. The eruption created the present shape and dimensions of Mt. Fuji (Miyaji 2002). Although it brought no lava flow, the total volume of tephra released by the Hoei eruption is estimated to be about 1.7 km^3 (Miyaji 2002). Smoke and ash were thrust about 10 km into the sky, and ashes dispersed eastward (toward Tokyo), causing darkness even in the daytime. Three meters of debris accumulated at the foot of Mt. Fuji and >6 cm of ash blanketed Tokyo area. Cinders and ash fell like rain and tephras changed the chemistry with time from dacitic to basaltic missing andesitic composition (Miyaji 2002).

There were no casualties but hundreds of thousands of people fled the area. The eruption destroyed crops and farming areas. Famines and social upheaval lasted for 10 years (Miyaji 2002). The Hoei Crater, visible to the right of the peak of Mt. Fuji, was the location of the 1707 AD eruption. Mt. Fuji has been fairly quiet since then, except for some steaming at the summit vent during 1780-1820. The Hoei eruption occurred on Mt. Fuji's northeast flank and formed three new volcanic vents, named No. 1, No. 2, and No. 3 Hoei vents (Miyaji 1988).

The Hoei eruption occurred after 49 days of the 1707 Hoei earthquake that hit the region on October 28, 1707 (White 1996). The earthquake was the largest in Japanese history

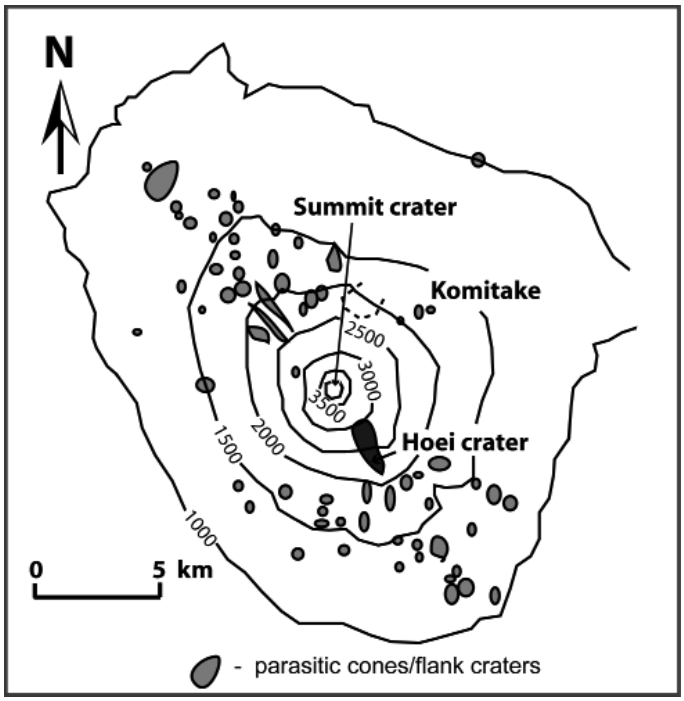

Fig. 6: Distribution of flank (parasitic) cones and craters of Fuji Volcano. The parasitic cones and craters are lining up in the direction of NW-SE (After Miyaji 1988). The contours are in meter

(M = 8.6) until the 2011 Tohoku earthquake surpassed it. It caused moderate to severe damage throughout southwestern Honshu, Shikoku and southeastern Kyushu. The earthquake and the resulting destructive tsunami caused more than 5,000 casualties (Nakamichi et al. 2004). This event ruptured all of the segments of the Nankai Megathrust simultaneously.

Future eruption of Mt. Fuji

In Mt. Fuji area, deep low-frequency earthquakes (DLFE) activities between 10 and 20 km depth was first reported in the early 1980s (e.g., Shimozuru et al. 1986) and concerns about possible future eruption appeared thereafter. Following those activities seismic observations around Mt. Fuji have been conducted by the Earthquake Research Institute, University of Tokyo (ERI), the National Research Institute for Earth Science and Disaster Prevention (NIED), and the Japan Meteorological Agency (JMA) to understand if the DLFE were due to the rise of magma to the surface. Concerns were particularly raised when a series of DLFE (about 700) occurred beneath Mt. Fuji, mainly in two periods during September-December 2000 and April-May 2001. During these periods, the occurrence rate of DLFE was 20–70 per month, which is ten times higher than the background level (Ukawa 2003).

Chronologically the DLFE swarm at Mt. Fuji started immediately after volcanic activity in the area around Miyake-Jima and Kozu-Shima region in July and August 2000 (Sakai et al. 2001). Besides the extremely high occurrence rate of the DLFE, there was no accompanying or following unusual shallow seismic activity or crustal deformation around Mt. Fuji (Ukawa 2003). The changes in tectonic and volcanic activity around the area suggest that the DLFE swarm at Mt. Fuji was triggered by the change of state of the deep magmatic system around Mt. Fuji (Ukawa 2005) as illustrated in Fig. 7.

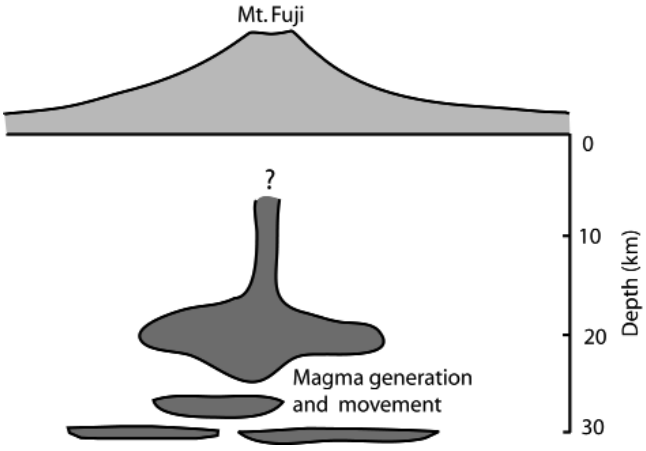

Fig. 7: Schematic representation of the possible process of magma generation and movement beneath Mt. Fuji (modified after Ukawa 2005)

The DLFE earthquake swarm at Mt. Fuji is considered to be one of the forms of this activity. Although no mechanism can be identified at present, the simultaneous activation along the Izu volcanic arc suggests a connection to a deep magmatic

system (Ukawa 2005). The movement of magma at the Kozu-Shima and Miyake-Jima may have induced additional magma movements or pressure change along the magma network in the crust or uppermost mantle. Therefore, the DLFE are the only information available to infer magmatic activity beneath Mt. Fuji (Nakamichi et al. 2004).

Mt. Fuji, previously regarded as dormant, is considered as an active volcano since the occurrence of swarm of DLFE in 2000 and 2001. Though Mt. Fuji is famous for its clean, pure water and amazing scenery, it has a high possibility of eruption in future. If Mt. Fuji were to erupt like it did in 1707, the damage could be devastating because current population living around the mountain is much higher compared to the population during the 18th century.

CONCLUSIONS

Japan is located in an area where the Pacific and Philippine plates subduct below the Eurasian plate. As part of the Pacific Ring of Fire, Japan is one of the most noted volcanic countries in the world, and Mt. Fuji is the largest volcano and the highest mountain of Japan. It is a composite stratovolcano and the history of eruption goes back to ca. 200- 700 ka (middle Pleistocene). Though Mt. Fuji looks like a single mountain, it is composed of four superposed cones, Sen-Komitake Volcano, Komitake Volcano, Older Fuji Volcano, and Younger Fuji Volcano in order of decreasing age. The volcanoes are characterized by eruptions of different types and natures. The last eruption (Hoei eruption) occurred in AD 1707-08 and created the present shape and dimensions of the mountain. It has been quiet since then.

The composition of the older rocks is andesitic, but the younger rocks are basaltic, which is unusual for the tectonic setting where Mt. Fuji lies. Besides its geological importance, Mt. Fuji has become a cultural icon to the people of Japan and to the outside world it is best known for its beauty. Previously regarded as dormant, the occurrence of swarm of deep low-frequency earthquake beneath Mt. Fuji in 2000 and 2001 provided a basis to consider it as an active volcano with a high possibility of eruption in future. If eruption like that of 1707-08 occurs, it can lead to enormous disasters because many more people are living around the foot of the volcano than ever before.

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3D modelling of geological features

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ABSTRACT

3D geological modelling deals with specific nature of the geological objects, and the process performs the visualisation with respect to rock strata geometry and has property modelling capabilities to enable the analysis of 3D geologic models. Mathematically derived subsurface geometry and properties are self-explanatory to the users as well as detailed 3D model is key element to the continuous and/or simplified layers for the numerical model. The technique has been applied in the Lesser Himalaya of central Nepal based on the implicit approach using sparse data.

MODELLING PERSPECTIVE

The geomodelling "*three dimensional (3D) geological modelling*" deals with the numerical description of geometry and properties of the subsurface. It emphasises the specific nature of the modelling of geological objects in comparison to traditional Computer-Aided Design (CAD) methods devoted to the modelling of manufactured objects. In recent years, geomodelling systems have been developed with high resolution 3D visualisation with respect to geometry as well as to property modelling capabilities in order to enable the construction and analysis of 3D geologic models in a way that general purpose Geographic Information Systems (GIS) and CAD systems simply cannot do (e.g., Mallet 1992; 2002).

The procedures to construct 3D geologic models must adapt to project objectives. However, the resulting models should have the level of stratigraphic details required by the most demanding application. The 3D geological modelling has started to upgrade classical maps by providing a definite 3D description, and they are constructed by modelling geological features as surfaces which intersect according to rules that allow the visual representation of the geological features of interest (Mayoraz et al. 1992; Mallet 1997; de Kemp 1998, 1999; Jones et al. 2002; Mallet 2002; Lemon and Jones 2003; Galera et al. 2003).

Structural information and an appropriate extension of the major geological units of the area of interest (AOI) can be extracted from these geomodels. Even for non-specialists, a model is self-explanatory. A skilled geologist may know to translate 2D into 3D – but no matter how experienced one can be, this mental translation is bound to be qualitative and sometimes inaccurate. Therefore, interactive and quantitative aspects of 3D geomodelling open up entirely new perspectives.

3D geomodelling software currently works in one of two ways, either using numerical algorithms to interpolate between data points such as borehole data (Krige 1966; Mallet 1992) or by using a more cognitive interpretative approach, which allows for the incorporation of expert geological knowledge between observational data points (Hinze et al. 1999; Sobisch 2000). In principle, 3D geomodelling software provides data models and functionality to represent geological situations in three spatial dimensions as geomodels (Apel 2006). Different 3D modelling software is available for geology and mining: 3D GeoModeller, 3D MOVE (Midland Valley), Avizo® Earth (VSG), EarthModel® FT, EarthVision, EVS & MVS - Earth Science Software, FracSIS, GDM (BRGM), GOCAD, GSI3D, Leapfrog, Petrel Geology and Geological Modeling, RockWorks, Surpac, Vulcan. In the present case study, GOCAD (*Geological Object Computer Aided Design*) has been used to model geology of the Lesser Himalaya in central Nepal.

CASE STUDY

The modelling site is bounded by the latitudes 27°37'38" & 27°45'37" N, and the longitudes 84°57'38" & 85°08'2" E. Litho-stratigraphy comprises six different units consisting of sedimentary, metamorphic and igneous rocks, Precambrian to Palaeozoic in age (Stöcklin and Bhattarai 1977). The area is geo-dynamically represented by the closure of the Mahabharat Synclinorium. The attitude of strata is variable; in general, strata in the southern belt are dipping 32°–85° northeast to north and 45°–81° to southwest in the northern belt.

The goal of case studies is to provide practical clues and guidelines about the integration of surface and subsurface data into a consistent 3D model made of a set of geological interfaces in the Himalayan terrain. The method has used

3D reconstruction of surfaces which are based on the interpolation of point data or data with linear attributes such as dip and dip directions (de Kemp 1999; Fernández et al. 2004) in that it requires a significantly smaller amount of data (Carrera et al. 2009). Generally, field geological mapping relies heavily on observations of the orientation of contacts between different units and the orientation of its internal fabrics. Such data can be used to determine the relative ages of different units (on the basis of crosscutting relationships) as well as allowing the extrapolation of surface measurements laterally or vertically downwards (Sides 1997).

The methodology has been implemented within a system based on ArcGIS functions, while GOCAD serves as a geomodeller and a database (Fig. 1). The data transfer between these software components was simply made through file exchanges. Point and curve objects with properties are saved as points, while line or polygon shapefiles with attributes can be imported into GOCAD directly. Other data types were converted and exported into a suitable format to import into the geomodeller. In fact, tools for 3D modelling are mainly designed for data-rich environment but many geological investigations are limited to sparse or poorly distributed data. This study has applied the innovative way to compute a model using optimum available data which include lithological boundaries, representative cross section and orientation vectors (Fig. 2a). Considering nature of data, the model setup was made by means of implicit approach (Caumon et al. 2007) to interpolate the data, and a GOCAD workflow has integrated the model properties for determining the spatial locations/geometry. The procedures intend to visualise geological information and to establish topological relationships among the analysed objects, coupling the data processing capabilities of ArcGIS with 3D modelling with basing on selective extraction of data and translation in the GOCAD format. The aim was to produce a mathematically and geometrically correct and a plausible 3D geological model consisting of the volume and shape of the geologic features based on a modelling algorithm that only uses surfaces and that intersects them following a series of geologically sound rules.

All the data related to geometry, topology and properties of the geological objects stored in the GIS database can be retrieved and used for 3D representation. The Digital Elevation Model (DEM) was processed in a GIS to be transformed as a point set with elevation attributes. Then, it was imported in GOCAD where z-property was calculated from the elevation values. A homogenous triangulated surface was then created from these points and interpolated to be used as the ground elevation reference surface. This interpolation was used for the gently smoothing of a surface where there is strong relief and the operation was conducted in such a way that altitudes were kept within the precision range of the DEM. Shapefiles (outcrop boundary curves, orientation vector points) without elevation values were then imported in GOCAD and projected vertically onto the

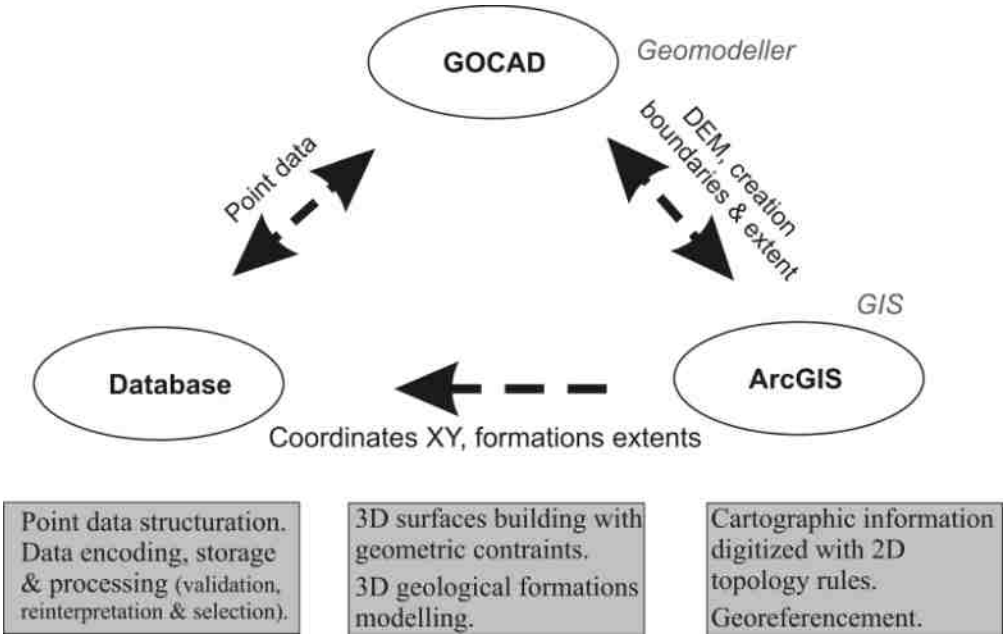

Fig. 1: System architecture of 3D geological modelling: A geomodeller "GOCAD", a GIS "ArcGIS" and a database (modified after Kaufmann and Martin 2009)

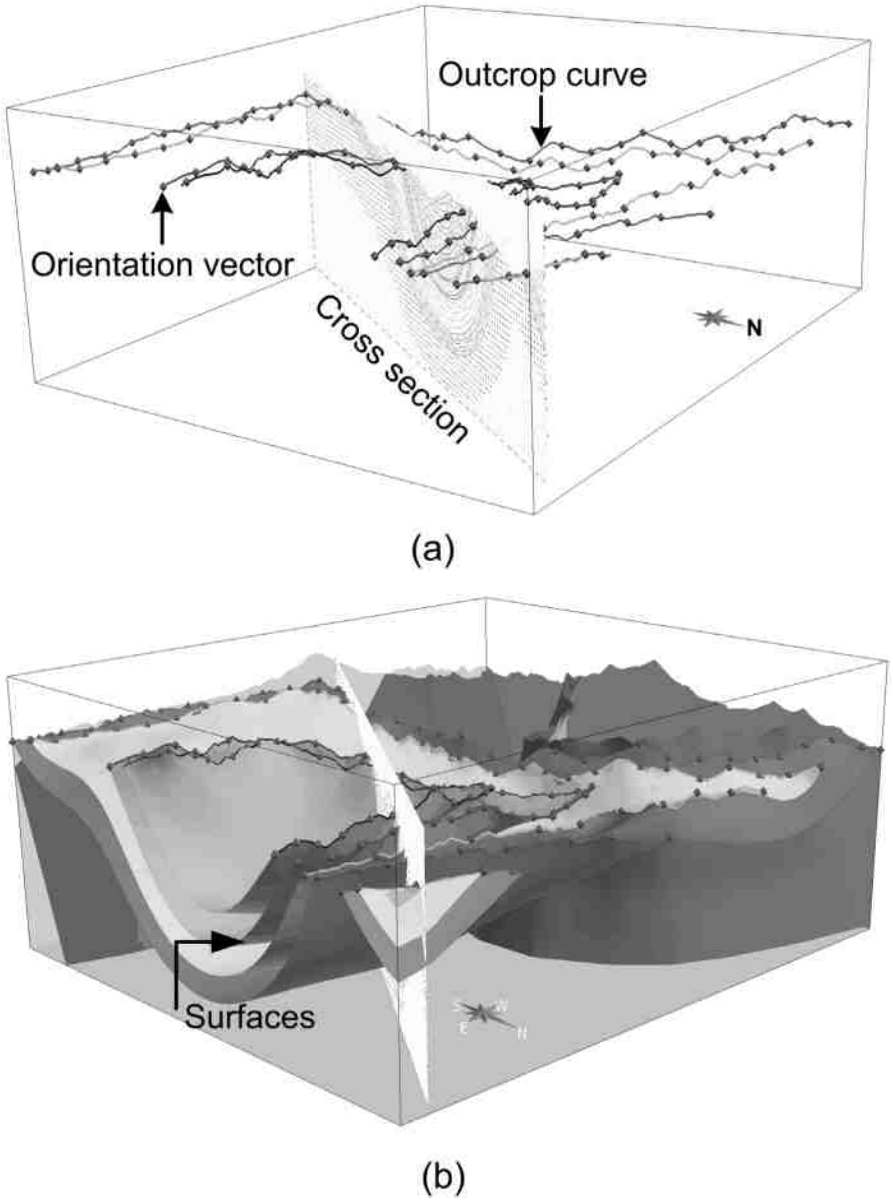

Fig. 2: (a) projected lithological boundaries (outcrop curves), representative cross section and orientation vectors, (b) computed surfaces by DSI

3D topographic surface (DEM.surf) created from DEM data. If necessary, border constraints can be used to move on a straight line in the z direction only.

Three basic GOCAD objects have been created with data exported from GIS: a 3D point set (VSet) with elevation values, a line set (PLine) including all the 2D linear elements with no elevation value, and a set of 3D lines representing the down-dip projection of bedding or foliation, and eventually the fold axes. Geological cross section was geo-referenced using "Section Tool" (Arndt 2012) and imported as 2D voxet in GOCAD. 2D voxet section was projected into 3D space of accurate location using script generated by the tool while exporting. Boundaries in the geologic cross section were traced as curve objects on the working plane which corresponds to geological outcrop units in the subsurface. Thus, the workflow is based on model refinement by editing the geometry in section and map views. One cross section was directly built in GOCAD using interactive tools additionally. The coordinates of an orientation vector (v) were implemented from the dip direction θ (azimuth) and dip ϕ angles through the following trigonometric formula

$$v = \begin{bmatrix} \sin(\theta)\cdot\cos(\phi) \\ \cos(\theta)\cdot\cos(\phi) \\ \cos(\phi) \end{bmatrix}$$

To support interpolation, the 3D vector has to be oriented normal (perpendicular) to a stratigraphic layer. By controlling the representation in space of the orientation vector, it takes advantage of a variety of interpolation schemes.

The model configuration was performed by setting appropriate constraints using various GOCAD plugins, and then Discrete Smooth Interpolation (DSI) algorithm was run to compute rock strata geometry. The DSI optimises all three spatial coordinates of mesh vertices. It allows to interpolate the functions of φ the discrete model, like geometry or properties, while honouring a set of constraints Ci. The algorithm converges towards a solution:

$$R^*(\varphi) = \sum_{\alpha\in\Omega} \mu(\alpha)\cdot R(\varphi|\alpha) + (\phi\cdot\varpi)\cdot \sum_{c\in C\approx} \varpi_c \cdot \rho(\varphi|c)$$

where, $R(\varphi|\alpha)$ is the local roughness at node α, $\rho(\varphi|c)$ is a constraint defined for node α, μ is a stiffness coefficient, and ϖ_c, $\phi.\varpi$ is weight coefficients (Mallet 2002). This generic method permits the usage of heterogeneous data as constraints for the interpolation. It is always reproducible, on what primary data an interpolated object is based on.

The interpolation utilities (process) run in interactive and iterative manner to generate a smooth surface which coincides with lines representing the original boundary surface. In this computation, four stratigraphic bottom surfaces were obtained (Fig. 2b). In some cases, surface adjustment was made locally by region interpolation with selective setting of control nodes, while for other regions it was not necessary to move during interpolation. Separate building of surfaces does not ensure that they are consistent with the correct stratigraphic order apart from the cross sections. In such cases, increased mesh density and minimum thickness constraints were applied to remove the crossovers. Range thickness constraints were used to hold the target surface within a certain distance from another surface. Thus, 3D surfaces of stratigraphic horizons were created following the basic modelling rules in the output. The surfaces are intended to form closed volumes representing geologic bodies, and thus act as "dividing walls" isolating 3D regions (Mallet 2002). However, the partitioning of the subsurface into 3D regions describing the topological space requires "welded" surfaces. It is therefore critical that the topology defined by the surfaces has to be unambiguous. Surfaces must form a closed volume and the line defined by the intersection of two surfaces must be unique and free of gaps.

After building all the surfaces of geological units, it is important to delimit top and base while outer borders of both surfaces are given by the AOI. In order to model the main stratigraphic units, the DEM was used as top surface while the base is a surface with a constant appropriate depth. A systematic sequence of steps has built the rock strata units from base to top. The operations have allowed the options to improve the modelling. A corollary is that a surface shall not self-intersect, for it would suggest that the volumes separated by this surface overlap each other. A structural model comprises not only surfaces fitting observation data, but also correct relationships between the geological interfaces.

Finally, a 3D volume model was constructed as Model3D (Fig. 3), here revealing a syncline structure and intrusive bodies. The resultant model is more consistent with current geological observations and theories i.e. the model is a closer representation of geological reality. The model consists of a sequence of volume elements, bounded on the top, bottom and sides by continuous functions across the modelling domain. Such a 3D geological model can be updated when new data becomes available or perturbed to account for structural uncertainties. Once a coherent 3D model is developed, dynamic visualisation is possible by slicing tools which allow a move into different sections to check the geometry of the different layers.

CONCLUDING REMARKS

It can be concluded that optimised approach of implicit modelling is quite illustrative to achieve a geologically reasonable solution even in areas where the data is sparse or uncertain. The accuracy of any 3D digital model will depend not only on the data, its density and quality, but also on the theoretical understanding of the underlying geology by the modeller. Users of 3D models must be able to understand the limitations of the data on which they base their assessments. Improvements in 3D modelling methods are allowing geoscientists to introduce a far greater level of realism into their 3D models. The users also need to be able to assess the risk associated with using 3D models, so that sound decisions can be made. The result of the modelling is a representation of the subsurface taking into account of available surface data and incorporating the conceptual understanding. Methodology applied has exemplified the approaches which used to generate 3D surfaces, and to give practical rules or clues to the resulting 3D geological model. Moreover, the modelling of subsurface geometry and properties is a key element to understand geo-hazard and risk (e.g. landslides). The detailed 3D model can also provide the continuous and/or simplified layers for the numerical model.

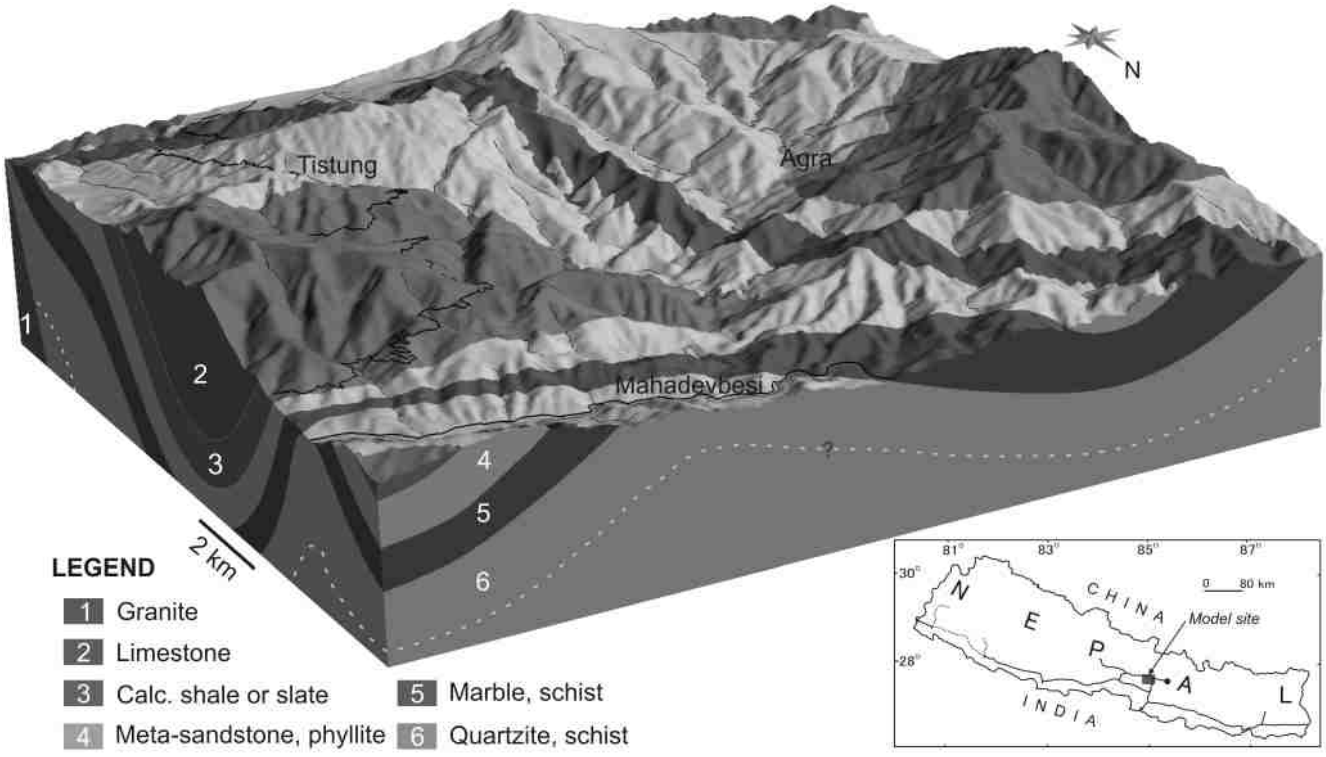

Fig. 3: 3D geological model of an area in the Lesser Himalaya, central Nepal

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Sedimentation at Phewa Lake due to landslide and its impact on rural livelihood

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ABSTRACT

Phewa watershed is a highest rainfall-receiving watershed of Nepal with 19 sub-watersheds. Phewa watershed has been mostly degraded due to landslide, soil erosion and rural road construction that ultimately results sedimentation at Phewa Lake. Rural roads are the major developmental activities in villages of this watershed and have a great role in socio-economic condition of local people. The government and rural communities of Nepal have been focusing rural road construction without considering terrain slope, terrain materials, and lithology and structure of the catchment area. Phewa watershed is made up of phyllite and quartzite as bedrock which are partially covered by residual and colluvial soils. It results in debris slides, wedge failure and gulley erosion. Heavy rainfall and groundwater in the watershed saturates rocks and soils that decreases shear strength due to increase of pore water pressure, triggering a landslide. The total of 313867.43 m^3 sediment is contributed by landslides in Phewa watershed. Landslides due to rural roads contribute 25593.33m^3 and natural landslides contribute 288274.10 m^3 of sediments. The sedimentation at Phewa Lake from Phewa watershed is going to damage scenic beauty of the Pokhara Valley. It has several negative consequences on livelihood of local people.

INTRODUCTION

Phewa watershed covers an area of about 123 square kilometer with prominent tourist attractions and play great role in improvement of environment (Sthapit and Balla 1998). The watershed area lies in most fragile Lesser Himalayan meta-sedimentary zone with folded, faulted and fractured rock rock strata feeded by intense monsoon rainfall events. Landslides, soil erosion, rural road construction in the cathment area and sedimentation in the Phewa Lake area are the major causes of land degradation. If the the average annual sedimentation rate of about 180000 m^3 continues, 80% of the Phewa Lake storage capacity would be filled up by sediments in the next 190 years (Sthapit and Balla 1998). As the annual silt deposit rate in the Phewa Lake ranges from 175000 to 225000 m^3, 4600000 m^3 volume of lake will be silted up in 175 to 200 years (JICA 2001). The landslides and floods are thought to contribute to an annual soil loss of 20-25 t/ha (JICA, 2001) and about 15 m^3/ha (Sthapit and Balla 1998). The increasing rate of rural road construction in Phewa watershed adds more sediment to the Phewa Lake.

The government and rural communities of Nepal have focused in rural road construction. It has positive role to the rural communities in relation to rural transportation and other socio-cultural dimensions. However, it has several negative consequences in relation to conservation of upstream and downstream lands, infrastructures and natural entities. Landslide and soil erosion at watershed areas are caused by unplanned rural road construction without slope treatment, no control mechanism of government and lack of environmental education among the people.

Precambrian to Paleozoic aged Lesser Himalayan meta-sedimentary zone of western Nepal is one of the vulnerable zones among morph-tectonic division of Nepal. It is vulnerable due to its rugged mountain topography, complex and fragile nature of the geological formations, active groundwater activities, soft soil cover, high intensity rainfall in the monsoon season, steep slope and unplanned developmental activities (Upreti 2001). The country frequently experiences landslides and debris flows due to steep slopes, topographical variation and geological characteristics, together with torrential rain during the monsoon season, Landslides cause loss of human life and damage to property. These phenomena not only cause loss of life and property but also pose severe threats to physical infrastructure, lakes and disrupt socio-economic development (Pradhan 2007). In Nepal, disaster take place year after year that cause loss of income and livelihood opportunities, properties and lives, starvation including displacement of affected families are the major implications of these disasters (Luintel 2004).

Phewa watershed covers six Village Development Committees in upstream area namely Dhikur Pokhari, Kaskikot, Sarangkot, Bhadaure Tamangi, Chapakot and Pumdi-Bhumdi. This watershed is the resident of different ethnic groups mainly by Brahmin and Chhetri (70%), Gurung, Magar and Ranabhat ((20%) and 10% occupational caste (JICA 2001). Phewa watershed is one of the most important natural entities, the charm and mystic beauty of which attracts a large number of tourists from all over the world each year.

STUDY AREA AND MATERIALS

Twenty two rural roads and sixty eight landslides were invented within the Phewa watershed. The landslides activated by rural road construction and natural landslides greater than 50 m^2 were the area of the study. The volumes of the landslides were estimated by measuring length, breadth and height using measuring tape. Discontinuities in rock strata were recorded using Brunton compass. Slope of the landslide were also recorded by using Abeny's level. GPS was used for the location and latitude and longitude record. The materials resulted from landslides are the source of sedimentation at Phewa lake. Semi-structured questionnaire were used to collect data from 75 households and 10 focus group discussions related to impact of landslides on rural livelihood.

RESULT AND DISCUSSION

The collected landslide data from the field are included for result and discussion. These data are analyzed quantitatively as well as qualitatively.

The landslide in rural roads contain minimum of 1 to maximum of 16 with approximate average value of 4 (Table 1). The minimum and maximum ranges of dipping of the rock strata, natural slope, joint set 1 and joint set 2 range from 15-80^o with average value 36^o, 25-70^o with 49.8^o, 40-90 with 75^o and 28-89 with 70.7^o, respectively . The latitude and longitude are ranging from 48^{o}17'65''N to 49^{o}90'09''N and 31^{o}22'90"E to 31^{o}29'38''E, respectively. From the value of coefficient of variation, the dipping of rock strata seem more heterogeneity compared to dipping of natural slope. The dipping of rock strata depend on tectonic activity and depositional situation. The dipping of natural slopes were changed by exogenetic geological processes according to time. The coefficient of variation of joint set 1 and joint set 2 show that there are little bit differences in homogeneity due to stress applied in different direction. High coefficient of variation in landslide volume indicates that the standard deviation is more than that of average value of volume. It means the volume of the landslide ranges from 20.64 m^3 to 212312.53 m^3 with average volume 4615.69 m^3.

Landslide measurement in Phewa watershed

The frequency of landslides reveals that maximum occurrence in Naudanda-Kaskikot-Sarangkot-Pokhara road and followed by landslide in outside the road and Dharapani-Bhadaure road and Ghantichhina-Makawanpur road (Table 2). The total of 313867.4299 m^3 sediment source was resulted from landslide in Phewa watershed. The highest sediment source (288274.1045 m^3) results from landslide in outside the roads. 61 landslides were observed in studied roads. 25593.32541m^3 sediment source results from these landslides. The maximum 11686.93159 m^3 sediment source was resulted from Naudanda-Kaskikot-Sarangkot-Pokhara road within landslide in road.

Table 1: Descriptive statistics of landslide in the study area

Characters	N	Range	Minimum	Maximum	Avg.	Std. Error	Std.	CV (%)
Landslide No	68	15.00	1.00	16.00	3..9412	.44242	3.64828	92.56775
Latitude (x)	67	-	481765	499009	-	-		-
Longitude (Y)	67	-	3122908	3129381	-	-		-
Rock- dip	35	65.00	15.00	80.00	36.0286	2.48169	14.68189	40.75065
Natural slope-dip	62	45.00	25.00	70.00	49.8226	1.12764	8.87901	17.82125
$Joint_1$-dip	24	50.00	40.00	90.00	74.9583	3.43758	16.84063	22.46666
$Joint_2$-dip	23	61.00	28.00	89.00	70.7391	3.82793	18.3581	25.95184
Volume (m^3)	68	212291.89	20.64	212312.53	4615.6975	3274.9737	27006.13	585.0931

Table 2: Landslide frequency and volume in the Phewa Lake watershed, Pokhara

S.N	Landslide in and out of roads	Frequency of landslide	Landslide volume (m3)
1	Bhadure-Tamangi Link	4	1022.3926
2	Banpale- Guntechour	1	95.333333
3	Dharapani-Bhadaure	5	1965.6586
4	Ghantichhina to makawanpur	5	525.65404
5	Bhadure-Thulakhet	2	114.96296
6	Kande-Sallyan road	3	699.38037
7	Naudanda- Adhikari danda	1	22.458333
8	Naudanda-Kaskikot-Sarangkot-PKR	16	11686.932
9	Outside landslides	7	288274.1
10	Pipadali-Guntechour	5	6556.7852
11	Primisti-Bhadaure	1	97.406222
12	Serachour	4	547.27407
13	Sarangkot-Toripani	4	825.85926
14	Sarangkot-Gyarjati-Pipaltari	2	58.662222
15	Sarangkot-Kaule	3	564.76593
16	Sarangkot-Sintal	3	742.90167
17	Vanjyang-Pame	1	30.275
18	Wangdi-Okhaldhunga	1	36.624
Grand Total		68	313867.43

The result shows that frequency of landslide is higher in rural road section but the sediment source is much higher in outside landslide. The vulnerability of hill slope is increased by rural road construction. The frequency of landslides is lower in outside the road but with higher sediment source indicates that overall Phewa watershed is still unstable and may increase more sediment source in future.

NATURAL SLOPE AND LANDSLIDE

In the Phewa Lake catchment area, 47% of the landslides occur in south east direction followed by 21% in south west direction, 16% each in north east and North West direction (Table 3).

Table 3: Landslides with respect to natural slope in the study area

Dip direction of natural slope (Aspect)	No. of landslide
NE	10
NW	10
SE	30
SW	13
Grand Total	63

The highest occurrence of landslide in south east direction indicate such direction is susceptible to landslide due to higher slope, discontinuities in rock strata during road excavation, relatively higher weathering rate and gulley erosion.

Dipping of natural slope

The dipping of natural slope is ranges from 20^{o} to 70^{o} (Fig. 1). The frequency of landslide is higher in 50^{o} to 55^{o} and gradually frequency decreases with increasing and decreasing the dip amount of natural slope. The average dip amount of landslides is 50^{o}.

The dipping of natural slope shows most of the landslides occur above 35^{o}. It means that landslides occurrence is higher when the dipping of natural slope increases.

Dipping of rock strata

The dipping of rock strata ranges from 10^{o} to 80^{o} according (Fig. 2). The average dipping of rock strata is 36^{o}. All the rocks are inclined. Fig. 2 also shows increase of dip amount of rock strata with slight decrease of frequency of landslide. It means that the land is comparatively stable when dipping of the rock strata increases due to the presence of hard rock such as quartzite. The landslide occurrence is relatively higher up to 30^{o} dip amount. It means that instability of land slightly increases when dipping of the rock strata decreases due to the presence of soft rock such as phyllite.

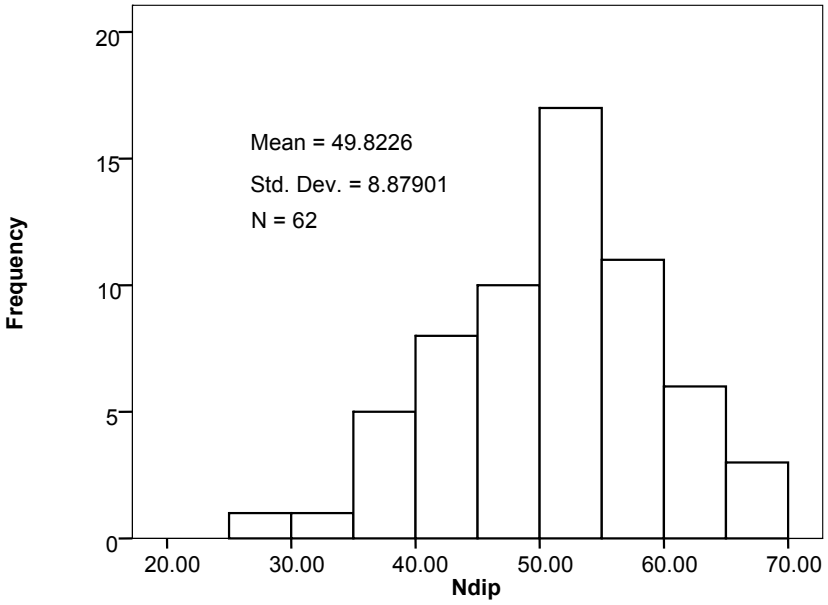

Fig. 1: Landslide occurrences with respect to dip of natural slope in the Phewa watershed

Table 4: Sediments in the Phewa Lake resulted from landslide.

S.N.	Categories	Volume (m^3)	Projected sediment sources resulted from Phewa watershed by landslide (m^3)/year	
			5%	10%
1	Sediment source by landslide in roads	25593.32541	1279.66627	2559.332541
2	Sediment source by landslide in outside the roads	288274.1045	14413.70523	28827.41045
3	Total sediment source in Phewa watershed by landslide	313867.4	15693.37	31386.74

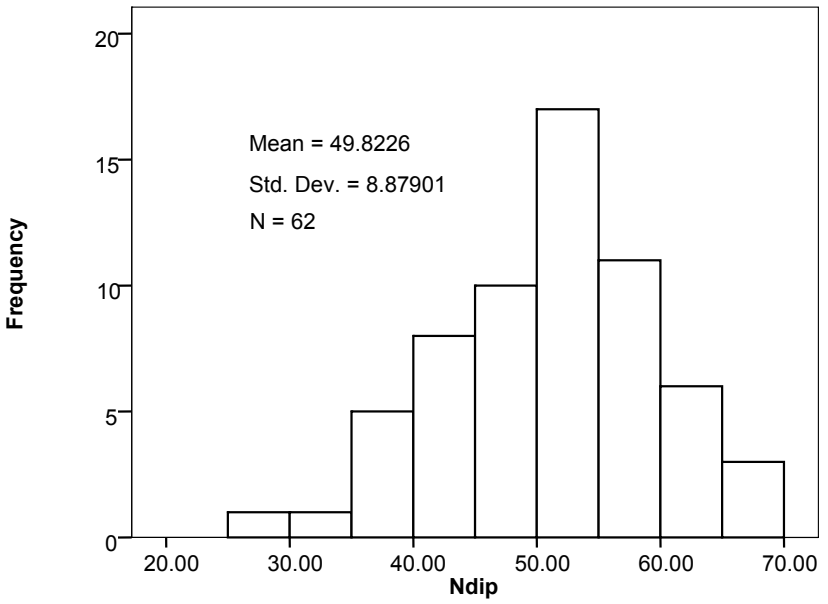

Fig. 2: Landslide occurrences with respect to dip of rock strata.

Table 6: Ranks of the negative effects of rural road construction/landslides by the people of Phewa watershed area of Kaski district.

Negative effects	Score obtained from FGD (10 groups)										Sum	Avg.	Rank
Loss of natural water sources (well, springs, ponds)	5	7	7	7	9	5	6	5	6	5	62	6.2	8
Damage to Irrigation canals/water pipelines	5	6	7	6	8	5	6	5	6	5	59	5.9	9
Loss of vegetation areas (Forest / shrub / Grazing land)	6	7	8	9	8	7	11	10	9	7	82	8.2	**3**
Loss of cultivated land	10	8	10	11	11	8	9	8	9	10	94	9.4	**1**
Displaced households/ increase number of vulnerable settlement area	9	7	7	6	8	6	9	10	9	10	81	8.1	4
Increase in crime (robbery, smuggling)	5	6	6	6	7	5	6	5	5	5	56	5.6	10
Increase in health and psychological problems	5	6	5	6	7	5	5	5	4	5	53	5.3	11
Decrease number of trekker and impact to trekking business	6	8	11	8	9	6	6	6	7	5	72	7.2	5
Increase tendency to relocate/migrate at roadside	5	7	10	8	9	5	6	6	7	5	68	6.8	6
Increase in road traffic accident	5	6	5	4	3	4	4	4	4	5	44	4.4	12
Increased dependency on market oriented products (low production of indigenous products)	5	7	8	8	9	5	6	6	6	5	65	6.5	7
Destruction of virgin lands	8	10	9	10	8	10	8	8	8	9	88	8.8	**2**

Sediment source from landslides

The total volume of the Phewa Lake is 4600000 m^3. Researchers estimate that if only 5% of the total sediment resulted from landslides alone at the same rate silted up to the Phewa Lake, the Lake will convert into a lacustrine plain within 293 years (Table 4).

Other sources of sediment from erosion, encroachments, cutting and filling from rural road construction etc. are not included in sediment source calculation in this study. It is estimated that other sources will contribute annually 5% to the total sediments resulted from rural roads and landslides.

People's responses toward causes of landslides due to road construction

The majority of the people (60%) revealed that the main cause of landslide in the roadside was the construction of rural road. On the other hand, about 31% people mentioned that it is due to other causes (Table 5).

People's categorization on negative effects of landslides

Pairwise ranking exercises was carried out to find out the people's opinion on the negative effects of rural road construction and their effect on landslide in the Phewa watershed area of Kaski district. According to Table 6, the results from the 10 focus groups discussion show that loss of cultivated land has got the highest score (94) followed by destruction of virgin lands (88), loss of vegetation area (82), displaced households/ increase number of vulnerable settlement area (81), Decrease number of trekker and impact to trekking business (72) and then increase tendency to relocate/migrate at roadside, increased dependency on market oriented products (low production of indigenous products), loss of natural water sources (well, springs, ponds), damage to Irrigation canals/water pipelines, increase in crime (robbery, smuggling), increase in health and psychological problems, increase in road traffic accident, respectively.

Table 5: People's perception toward causes of landslide.

Category	Cause of landslides due to the rural road construction			
	Yes, main cause	Yes, some cause	No cause	Total
Response frequency	45	23	7	75
Percentage value	60	30.67	9.33	100

The negative impact from the landslides is loss of cultivated land, the second is destruction of virgin lands and the third is loss of vegetation area in this Phewa watershed area of Kaski district. Natural, social, economical, environmental and biological negative effects of above tabulated lists were faced directly or indirectly in various levels by the people of this watershed area. The negative impact of landslide on cultivated land shows reduction of crop production that ultimately affect on rural livelihood. Landslides destruct natural environment, socio-economic condition of people and natural vegetation.

CONCLUSION

Sixty eight landslides were inventoried in six Village Development Committees in the catchment area in and outside the rural roads. The rural roads resulted landslides contribute 25593.33 m^3 sediments. The landslides outside the rural roads supply 288274.10 m^3 sediment sources. A total of 313867.4 m^3 sediment is produced from landslides in Phewa watershed. If 5% of the total sediment resulted from landslides is deposited into the Phewa Lake, the total volume of the Lake will be displaced by silt within 293 years.

Natural, social, economical, environmental and biological negative effects of landslides to the rural people were faced directly or indirectly at various levels in Phewa watershed area. The loss of cultivated land results reduction in crop production that play negative role in rural livelihood.

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Availability assessment of groundwater resources for effective irrigation

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ABSTRACT

We are not utilizing the groundwater resources properly even though the country holds high potential of this resources. The country will become socio-economically sound soon if the groundwater resource is used more scientifically. The use of groundwater in irrigation sector is cost effective, easy available, quick result oriented, reliable, self control, cheap, handy, low risk, manageable and environment friendly. Besides, it is available during the dry (winter and summer) season when the most of the surface water will be dried up. The unique and important feature of groundwater resources is its availability throughout the year. Therefore, the groundwater resources could be a "**Gift of Nature** " for Nepal if we could know and understand it properly. A lot of improvements should be done in the sector of sustainable utilization of this resource especially in the legal, institutional, and technical including policy aspects as well.

BACKGROUND

The Terai Plain of Nepal is a part of the biggest groundwater basin in the world known as Indo-Gangetic Basin and is highly potential for groundwater storage. The unconsolidated porous material of the basin has high capacity to store or release the groundwater resources. Presently, about 1.4 million people are living in the Terai and most of them are utilizing the groundwater resources for drinking, domestic, irrigation, industries, and for cattle use purposes. So it can be concluded that approximately half of the entire population of Nepal has been depending on the groundwater resources directly. Among of various uses, high amount of the groundwater resources is utilized in the sector of irrigation itself and its evidence is given by the 300,000 ha irrigated land of Terai from this resources. It is about 23 % of the total irrigated land of the country. There will be high demand of irrigation during winter crops while most of the surface drainages will be dried up at the same time. Therefore, the trend of groundwater utilization for irrigation is rapidly increasing. In addition, quick result, reliable, self control, cheap, handy, low risk, environment friendly, manageable, adaption of local technology and appropriate in climate change condition are also a additional factors of its demand in irrigation.

PREVIOUS STUDIES

Various studies have been done in the field of groundwater resources of Nepal especially in estimation of groundwater balance. However none of them have same result. Duba (1982) has considered recharge to the Bhabar zone and to the shallow aquifer of south of Bhabar zone. According to him, the total area of Bhabar zone is 4014 sqkm and mean annual recharge is 685 mm (33.5%) of annual rainfall. The direct average annual rainfall recharge to the shallow aquifer (south of Bhabar) is 429 mm. Jenkins (1983) study has based on some C14 isotopes in the Butwal region between the Siwaliks, and the boarder, and has suggested some boundary recharge from subsurface Siwalik sediments in to the Terai alluvium like BLGP. Electrowat (1984) estimated potential recharge to Bhabar zone, generally based only on rainfall recharge (ignoring the river bed infiltration and upward leakage) is about 465 mm. Kenting (1984) estimated direct rainfall recharge to the shallow aquifers south of the Bhabar zone is 124 to 370 mm. Groundwater Development Consultant GDC (1994) estimated potential recharge is 450 mm after reducing safety factor and for conservative value for planning purpose. Modeling works of Tahal (1992) present a groundwater balance for the Bhabar zone which allows that 42 % rainfall (1100 mm) reach the aquifer , this study also considered recharge inputs from stream which across the Bhabar Zone. UNDP (1992) presents that the annual recharge of Terai is 5800 MCM.

POTENTIAL RECHARGE OF GROUNDWATER IN TERAI

Let us consider that the entire Terai plain is a huge groundwater basin where groundwater inflow and outflows naturally and makes groundwater system. In the system the differences between the total inflows and outflows are equal to any change in groundwater storage. In this condition the non equilibrium balance is set up in the system. Which is denoted by:

Where,

I is total rate of groundwater inflow, O is total rate of groundwater outflow and S_{bal} is volumetric rate of

groundwater stored or released. The unit is MCM/yr. The inflow and outflow of groundwater have different parameters which are as given as below.

Groundwater inflow	Groundwater outflow
• Precipitation (Q_{pre}) • Inflows from surface water (Q_{surf}) • Lateral subsurface inflow (Q_{lsi}) • Upward leakage (Q_{up})	• Discharge at springs (Q_{Spring}) • Discharge to surface water ($Q_{surfout}$) • Abstraction (Q_{well}) • Lateral subsurface outflow (Q_{lso}) • Downward leakage (Q_{dwn}) • Evapotranspiration (Q_{evapo})

On the basis of available data related to the groundwater sector , the specific yield of Terai is about 0.2. In the same way, the annual fluctuation of groundwater level for unconfined aquifer is about 1.5 m and the surface area of main Terai is about 29838 sqkm. Based on these data, the potential annual storage in the unconfined aquifers of the main Terai is about 8951 million cubic meters (MCM). If the recharge computation is made on the basis of hydro geological method by the formula,

$$S_{gws} = BS_y \Delta\varphi/\Delta t.$$

Where, S_{gws} is rate of groundwater stored or released MCM ; B is surface area of the aquifer -29838 Km^2; Sy is specific yield (dimension less) - 0.2; $\Delta\varphi$ is difference in water table - 1.5 m (ave); and Δt is length of time (year) - 1 year. In the case of deep confined aquifer, the area of Bhabar zone of Nepal is 4014 sqkm and mean annual infiltration is 685 mm. Thus the annual groundwater recharge from the Bhabar zone is 2762 mcm which is considered as recharge of confined aquifer through horizontal flow. Therefore, the total annual storage of groundwater in the Terai is 11713 MCM .

If the groundwater recharge from the hydro-metrological methods is computed then the result will be nearly similar to the result obtained from hydro geological method. Let's see the D. Duba/HMG 1982 calculation. According to him the area of Bhabar zone is 4014 sqkm and means annual infiltration is 685 mm. Thus the annual groundwater recharge from the Bhabar zone is 2762 million cubic meters. In the same way, the area covered by the main Terai is 29838 sqkm and the mean annual vertical infiltration is 294 mm. Thus the potential recharge in unconfined aquifer is 8837 MCM . Thus the total potential annual recharge of the Terai is 11599 mcm. Both of methods have indicated approximately same result of groundwater recharge of Terai. Therefore, it is better to say that the annual recharge or storage of groundwater resources of Terai is about 11700 mcm.

Present (2010) outflows of groundwater resources

There are various parameters of outflows of groundwater system mentioned as above. However the abstraction by people for irrigation, industries and potable use and cattle are taken in account in this paper because huge volume of groundwater is abstracted from these sectors. As per the data available from institutions which have been involving in the fields of irrigation, industries, domestic and cattle the total abstraction of groundwater in 2010 is 3001 MCM which is about 26% of the total annual recharge. Out of this, outflows from irrigation (DTWs and STWs) is 2246 MCM (19%), from industries (DTWs) is 197 MCM (1.7%), from potable use is 166 MCM (1.4%) and Cattle use is 4 MCM (0.03%) mcm. In addition, the lateral subsurface flow is also a main factor for groundwater outflows. Thus, from lateral subsurface flow about 388 MCM /y outflows annually. The applied formula is

Where, Ql_{so} is flow rate through the stream tube (m3/day); T is transmissivity (m2/day) -1500 m2/day; Ws is width of the stream tube (m) - 885 km; $\Delta\varphi$ is discrete difference in hydraulic head (m)- 1; Δs is discrete difference between contour line m-1250 and $\Delta\varphi/\Delta s$ (hydraulic gradient) is 0.0008 (1/1250 m). The abstraction rate is considered as 10 l/s for STWs and 40 l/s for DTWs (irrigation) and 30 l/s for DTWs (industries). The operation hours of DTWs and STWs are assumed as 600 hrs per year for irrigation for while 2190 and 2920 hrs per year for industries and domestic use (drinking purpose). The irrigated area from each DTWs is taken as 40 ha and from STWs is 2.5 ha. The population by 2015 is calculated as 13997684 on the basis of growth rate 2.25 of 2001. Formula is.

$$P_n = P_o (1+r)^n$$

Where, P_n is population in n^{th} year; P_o is present population (11205288 in 2001); R is population growth rate (2.25) and n is number of years (10 years).

Irrigated areas and Tube wells by the end of APP (2015)

According to the target of the Agriculture Perspective Plan (APP 1995), about 175000 STWs and about 1250 DTWs would be made at the end of APP. The irrigated land from STWs will be about 437500 ha and from DTWs will be 50,000 ha. The total irrigated land from DTWs and STWs will be about 4, 87500 ha. In the case of groundwater utilization about 3924 MCM (33.5%) is in irrigation (DTWs and STWs); abut 217 MCM (2%) in industries (DTWs); about 184 MCM (1.6%) in potable use and 5 MCM (0.04%) in cattle use. The lateral subsurface flow remained as same in previous case. The abstraction rate is considered as 10 l/s for STWs and 40 l/s for DTWs (irrigation) and 30 l/s for DTWs (industries). The operation hours of DTWs and STWs are

assumed as 800 hrs per year for irrigation for while 2190 and 2920 hrs per year for industries and domestic use (drinking purpose). The population by 2015 is calculated as 15300635 on the basis of growth rate 2.25 of 2001. Now the P_n is population in n^{th} year; P_o is present population (11205288 in 2001); R is population growth rate (2.25) and n is number of years (15 years).

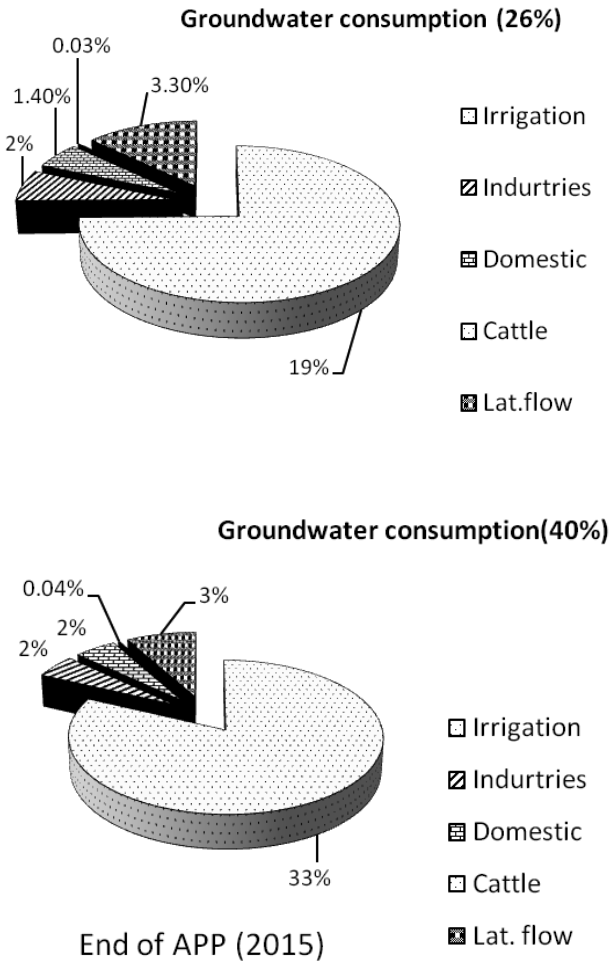


Fig. 1: Optimum number of tube wells and water consumption in irrigation (National Water Plan-2005)

According to the National Water Plan 2005, groundwater potential for irrigation is about 612000 ha. To irrigate the land about 200000 STWs and about 2800 DTWs should be made. Let's assume that the operation hours of STWs and DTWs will 800 hrs per year then the annual groundwater abstraction will be about 6080 MCM . It will be about 52% of total annual recharge i.e. 11700 MCM . If the double of 406 MCM (4%) made just double i.e. 812 MCM (8%) in another 10 years i.e. 2025 . The total volume is about 6892 mcm and it is about 60 % only.

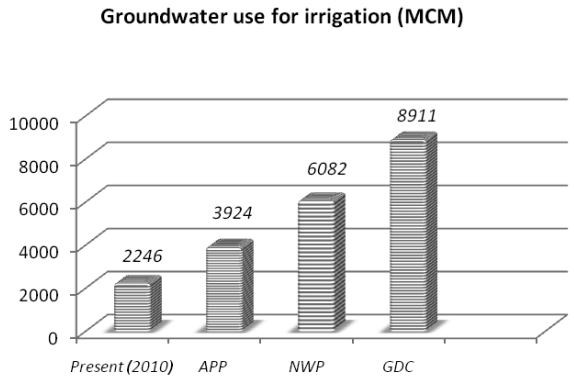
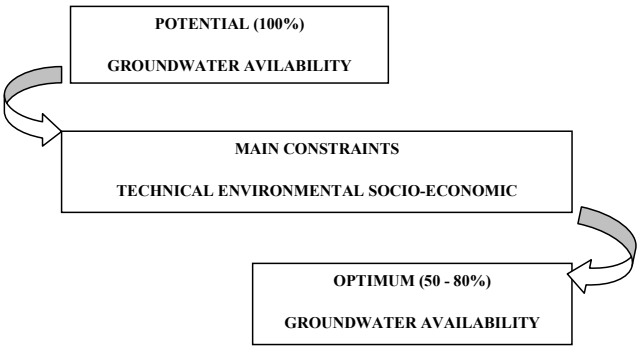


Fig. 2: Tube wells and water consumption in potential area proposed by GDC

According to the Reassessment of the Groundwater Development Strategy for Irrigation in the Terai , GDC, UK the potential area is about 916000 ha. In which potential for DTW is about 190000 ha and for STW is about 726000 ha. When we will ready to meet the proposed target, then it should need to construct about 4750 DTWs and about 290400 STWs. Let's assume the all STWs run about 800 hrs per year in the yield of 10 l/s then the total consumption of groundwater will be about 8364 MCM . Similarly, the all DTWs run 800 hrs per year in the rate of 40 l/s then the total consumption will be about 547 MCM . Thus the sum groundwater consumption from both DTWs and STWs will be about 8911 MCM which will be about 76 % of total recharge. On the basis of available recharge it is considered within the limit.

The case is just against the mentioned approach if consumption from STWs only is taken in consideration. The consumption from STWs itself will be the 99 % of total annual recharge i.e. 8951 MCM of unconfined shallow aquifer. Therefore, the use of 99 % groundwater is against the general principle of optimum utilization of groundwater i.e. about 50% to 80%.



On the basis of groundwater availability in deep confined aquifers taken 50 % (1381 MCM) only, it is possible to make about 12000 DTWs instead of 4750 of GDC. About 480000 ha land can be irrigated from these DTWs if the abstraction rate and running hrs per year is taken same as mentioned above.

Thus the consequence is that the potential area of DTWs will be 670000 ha instead of 190000 of GDC. In other hand, if the 70 % (6266 MCM) of potential recharge of STWs will be taken in consideration then the number of STWs will be about 217500 and the irrigated land will be about 543700 ha. In this new situation about 7647 MCM groundwater will be consumed which is about 65 % of total recharge.

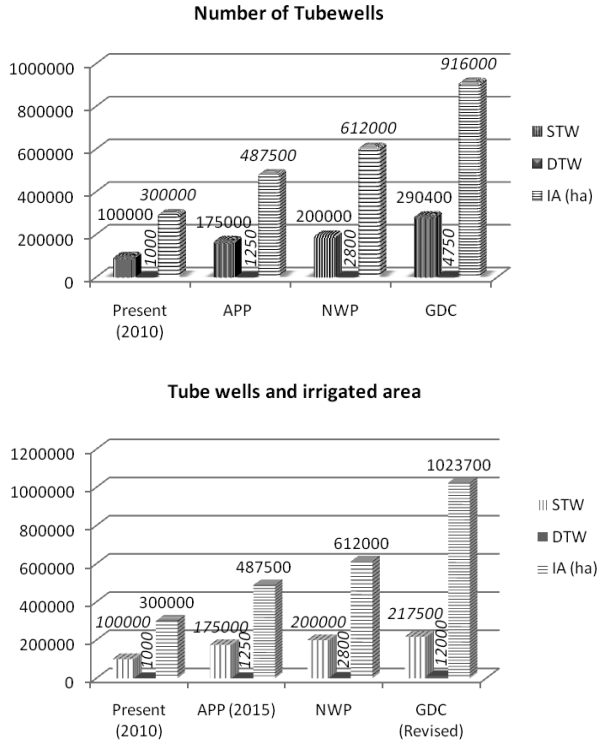


Fig. 3: Emphasized districts for groundwater irrigation

Jhapa, Siraha, Saptari, Dhanusha, Mahottary, Chitwan, Rupandehi, Dang, Bardiya, and Kailali districts are more emphasized for groundwater irrigation because these districts have least surface drainages in comparison to the other districts.

Main issues of groundwater development and management in Nepal

1. Institutional aspect: should be established a proper organizational set up either under the department of irrigation or separate independent organization (Department of Groundwater Resources).

2. Legal aspect: should be made groundwater act and law for better management and conservation of groundwater resources (quality and quantity).

3. Policy aspect: Groundwater policy for sustainable utilization focusing to socio-economic and environmental approach.

4. Technical:
   - Clear identification zoning of DTWs and STWs area in each district.
   - Clear identification and zoning of Thokuwa and Dhikuli area for STWs in each district.
   - Clear identification of present status of DTWs and STWs, and real irrigated areas in each district.
   - Implementation of inventory scheme of TWs (DTWs, STWs, hand Tube wells, dug wells) belongs to all government and non government agencies.
   - Update of GDC map in 1:25000, district wise.
   - Implementation of pipe line projects i.e. 32000 ha of Terai Groundwater Project and 8000 ha of Birganj Groundwater Irrigation Project.
   - Implementation of Conjunctive use of groundwater in large surface irrigation projects (60,000 ha) as per APP.

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Climate change mitigation by preserving carbon sinks and geological sequestration of carbon dioxide

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ABSTRACT

Nepal is among the most vulnerable countries in the world with regard to climate change because of high rate of temperature rise. Most of the energy demand is still met through traditional energy sources obtained by deforestation. This trend enhances the climate change because of the decreased consumption of CO_2 by the plants and release of CO_2 through soil erosion, landslides and floods. Unpredictable climatic conditions, steep topography and land degradation also causes landslides, floods and soil erosion. All of these disasters and deforestation have caused depletion of natural carbon sinks and spreading of the carbon dioxide in the atmosphere from the geological formations. To address all these issues, biomass energy obtained from the briquetting of unwanted and insignificant plant species has great potentiality. Present study identifies the bio-briquette production status and its benefit over forest wood including preservation of geological storage of carbon dioxide and natural carbon sinks. It is found that bio-briquette has health, environment, economic as well as energy and time efficiency benefits. It is estimated that about 377 tonnes of CO_2 emissions was reduced in 2007 by replacing firewood with bio-briquette from the four bio-briquette producer groups and therefore it helps to preserve geological sequestration of carbon dioxide and mitigate climate change.

INTRODUCTION

The energy demands of modern societies are steadily increasing as a consequence of economic growth, with primary energy demand increasing by more than 50% since 1980 (World Energy Council 2011). Much of the energy is satisfied either by non renewable fossil fuels or by the use of traditional fuelwood. There is considerably high rate of increase on fossil fuel consumptions compared to nuclear and hydro powers. According to International Energy Outlook (IEO), world energy consumption will increase by 49 % during 2007 to 2035 (EIA 2010). This trend causes energy scarcity and the increased emissions of green house gases (GHG) that result from the burning of fossil fuels. Fig. 1 shows the annual GHG emissions broken down into 8 different sectors for the year 2000 (Rhode 2006). It shows that the sectors related to energy production, processing and distribution are the major sources of anthropogenic GHG emissions. Among the GHG, the emissions of CO_2, are directly proportional to energy consumption. Such emissions cause climate change and activities aimed to mitigate it should therefore reduce the GHG emissions preserving carbon sinks.

In Nepal, most of the energy demand is still met through traditional energy sources of forest wood (Fig. 2), which are obtained by deforestation. This trend reduces the energy source and enhances the climate change because of the decreased consumption of CO_2 and release of CO_2 through soil erosion. Needless to say, forests are the prime natural carbon sinks and are being destroyed either for the energy supply or for the shelters. Carbon (C) emissions from deforestation and degradation account for about 20% of global anthropogenic emissions (IPCC-WGI 2007). Deforestation is the single largest source of land-use change emissions, resulting in emissions of more than 8Gt CO_2/yr (Baumert and Pershing 2005). In order to reduce both the energy scarcity and GHG emissions, environment friendly alternative energy resources are to be promoted. Among such energies, bio-energy based on briquetting of biomass has a tremendous potential especially in the developing countries. This paper explores all aspects of benefits and demerits of bio-briquette in terms of GHG emissions, carbon sink preservation and cost of fuel by utilizing the existing case studies and literatures from around the world.

BIO-BRIQUETTE

Background

Because of the difficulty on the transportation and storage of agricultural residues or lack of proper knowledge and skill to convert them into the fuel, biomass largely remains unutilized in many countries. Densification, which upgrades a low-bulk density material into a denser product, carries enormous significance in converting agricultural and wood-processing residues into a more usable form of fuel. Densified biomass being used as low cost alternative energy in many countries is mostly in the form of briquettes and therefore it is called bio-briquette (see Fig. 3). Briquetting

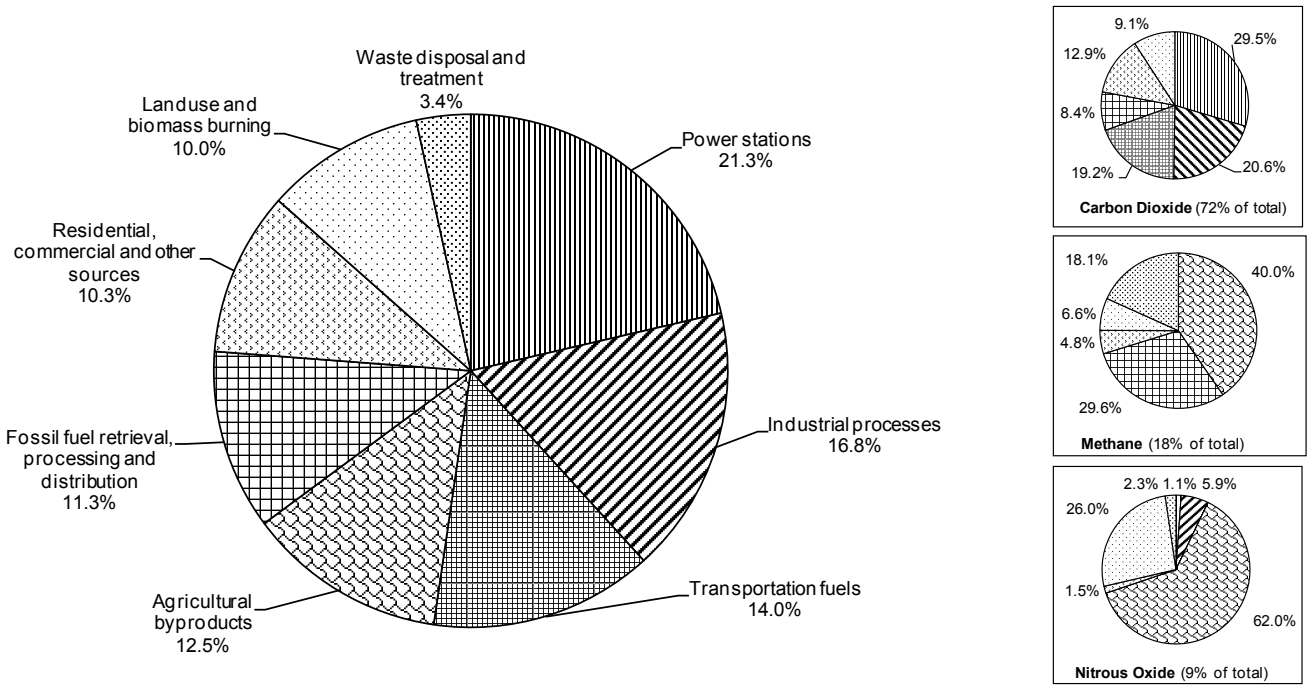

Fig. 1. Global anthropogenic greenhouse gas emissions for the year 2000 (redrawn after Rhode, 2006)

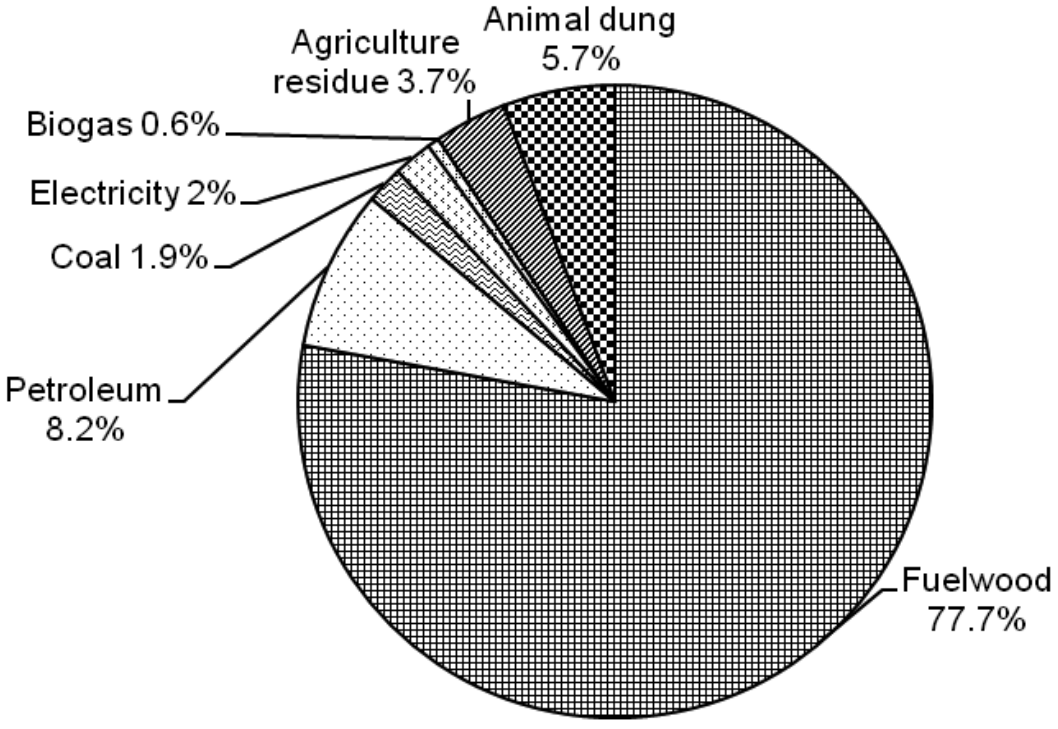

Fig. 2. Share of fuel consumption by fuel type for the year 2008/09 (redrawn after WECS, 2010). Total energy consumption for this year was 401 Million Giga Joule

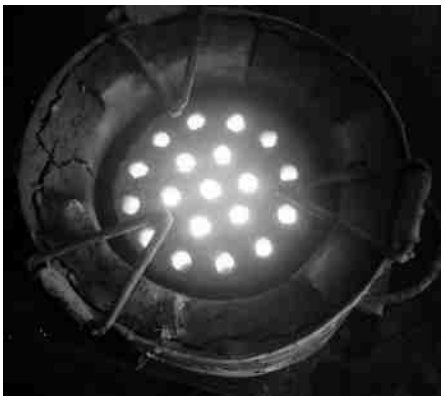

Fig. 3. A bio-briquette burned in a briquette stove

is the process of converting low bulk density biomass into high density and energy concentrated fuel briquettes. It consists of unburnt organic material, commonly called char which is ground or pulverized, mixed with mud rich in clay particles and water; and is given a definite shape by putting in a molding instrument. Biomasses used for producing bio-briquette includes: agricultural residues, rice husk, sawdust, hostile forest plant Eupatorium adenophorum (banmara), waste paper, bagasse, cotton stalk, groundnut shell, sugar mill waste, tea waste etc.

Benefits

Bio-briquette has many benefits including environmental, handling and transportation benefits, cleanliness and health benefits, time savings/efficient, economic and employment benefits and reducing GHG emissions. The traditional practice of burning of agricultural residues produces smoke and particulates because of incomplete combustion which is dangerous for health. By replacing this practice with bio-briquette, such environmentally harmful activities will be reduced and wastes utilized for low cost energy. Bio-briquette also reduces pressure on fuelwood and ultimately prevents soil erosion. Effective use of antagonistic plant for forest like *Eupatorium adenophorum* makes environment green and clean by preventing floatation of ashes in the air. For handling purpose, forest woods not only need to cut and arrange for the delivery, it has to be split into suitable sizes after delivery as well. Quantity of wood needed by a large institution requires a woodpile for storage. Bio-briquettes are ready to use directly from the sack and need little space for storage. The kitchens can be much cleaner as briquette produces significantly less smoke and reduces Indoor Air Pollution (IAP) compared to fuelwood/coal. It also reduces the amount of open-flame related accidents.

In one of the study in Uganda, it is found that briquette stoves cook faster. In a study at NAST (Singh 2011), different fuels were used to boil water under similar conditions and laboratory tests were conducted using an appropriate stove to boil water using a kilogram of each fuel. While cooking food for 5 persons almost all of the briquettes show better results than fuel-wood either in terms of the total cooking time or in terms of the amount of fuel consumed as shown in Fig. 4. Bio-briquette has social benefits for income generation and creating capacity building through community engagement. The cost of cooking using briquettes is comparable to fuelwood and less than kerosene. Shrestha, 2006 analyzes complete financial benefits of using bio-briquette compared to using kerosene in Nepal (Table 1). It shows that by using bio-briquette the cost can be reduced by almost 4 times per

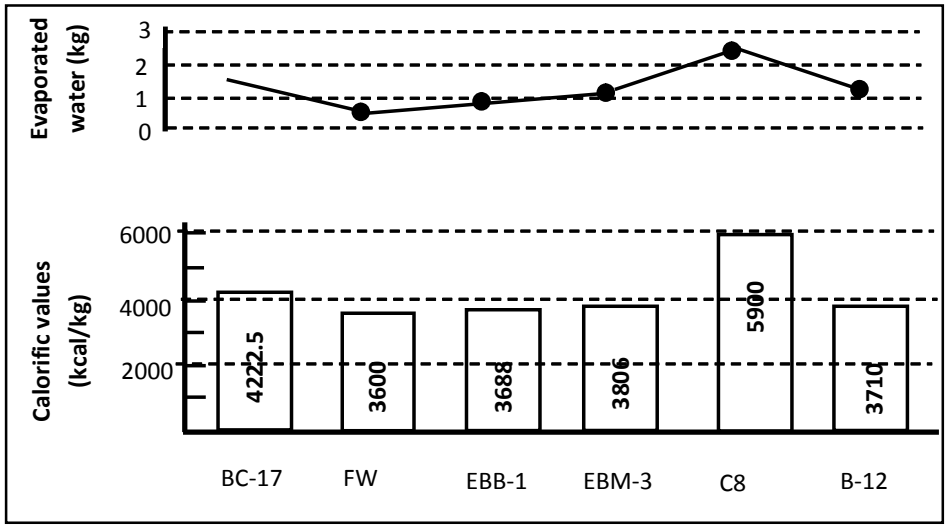

Fig. 4. Calorific values of various fuels and the amount of water evaporated by each fuel (redrawn after Singh 2011)

month compared to the use of kerosene. Quite good numbers of workers can be employed in briquette companies and residue producers can earn increased income from otherwise disposable materials. In a study of IDS Nepal, in September 2010, one of the producer groups in Lalitpur earned USD 155.63.

Table 1: Tentative comparative financial performance of briquette with kerosene (Shrestha 2006)

Financial Analysis	Briquette	Kerosene
Cost to buy a stove	$2.85	$5.00-$21.40
Fuel cost by weight	$0.178/kg	$0.60/L
Fuel cost for one month	$4.26/mo	$18/mo
Cost per MJ energy generated	$0.01/MJ or 0.67 NER/MJ	$0.02/MJ or 1.16 NER/MJ
Caloric value by weight	18.73 MJ/kg	36.27 MJ/L
Caloric value per $1 US	105 MJ/$1	60 MJ/$1

Means of reducing GHG emissions

The concentration of CO_2 in the atmosphere has been increasing because of the human activities. As discussed in section 1, increased consumptions of non renewable fossil fuels in various sectors is the root cause of CO_2 and other GHG emissions. In Nepal about 77 % of the total energy supply is satisfied by fuelwood (Fig. 2) and the average annual growth of its consumption is around 2.5% (WECS 2010). 92% of the total household energy consumption in Nepal in 1994-95 was biofuel. The shares of fuelwood, agricultural residues and animal wastes in the total biofuel use for energy were 75%, 16% and 9% respectively (Sharma and Bhattacharya 1997). Therefore, the strategy on energy supply should have aim of decreasing the consumption of fuelwood and promote the use of environment friendly alternative energy. Among the alternative energy, bio-energy produced from bio-briquete has a tremendous potential in Nepal as discussed before.

It is difficult to quantify the reduction in the amount of CO_2 emission by the use of briquette; however, some reports suggest the decrease in CO_2 emissions by replacing fuelwood with bio-briquette. In a study, it is found that replacing fuelwood by bio-briquette avoids the emission of an estimated 6.1 tonnes of CO_2 per tonne of briquettes used (www.ashdenawards.org), According to a study, 1 kg of briquette in an average produces 400gm carbon; to generate equivalent energy 931 ml kerosene (630gm Carbon) is required (Jaques 1992). Therefore 1 kg of briquette saves 230gm carbon. In our study, we compare CO_2 emissions between the use of fuelwood and the bio-briquette. We estimate that about 377 tonnes of CO_2 emissions was reduced in 2007 by replacing firewood with the use of bio-briquette from four bio-briquette producer groups (Table 2).

Table 2: Estimated CO_2 emission reductions while replacing firewood with bio-briquette in 2007

Producer Groups	Briquette Units	Equivalent Firewood (kg)	Emissions Reductions (tonnes CO_2)
Bishanku Narayan	35,000	87,500	160
Nabadurga	7,500	18,750	34
Marsyangdi	20,000	50,000	92
Panchpokhari	20,000	50,000	92
TOTAL	82,500	206,250	377

Consumption pattern

Various types of bio-briquettes have been produced and marketed in Nepal since 1982. The types include mostly beehive bio-briquette, pellets, one hole husk etc. Present study analyzed the consumption pattern of the briquette in the Kathmandu valley (Fig. 5). This figure reveals that 55% of the briquette is used to heat the baby, women and elder people, 25% is used for house heating/warming, 15% is used for office heating and 5 % only used for cooking purposes.

Precautions

Certain precautions are necessary for sustainable development and promotion of bio-briquette. *Eupatorium adenophorum (Banmara)* may not be available throughout the year at a place and other raw materials will be limited. Bio-briquettes can be less efficient in higher Himalayan and cold regions as it may absorb moisture. If stored in cold and humid place briquettes absorb moisture and when burnt, releases smoke which degrade surrounding areas. If burnt in non-ventilated room, it may produce undesirable health effects as it absorbs O_2 while burning. While grinding the char there is floatation of molecules in the air which may adversely affect the respiratory system of people.

GEOLOGY, SEQUESTRATION OF CO2 AND BIO-BRIQUETTE

There are great implications of use of bio-briquette to the geological sequestration of CO_2. Pore spaces within soils and rocks serve as a sink for atmospheric carbon dioxide and avoid its release to the atmosphere. When the soil got eroded, the rocks got weathered and landslides and floods occurred, the carbon stored within the soil or rock got released in the

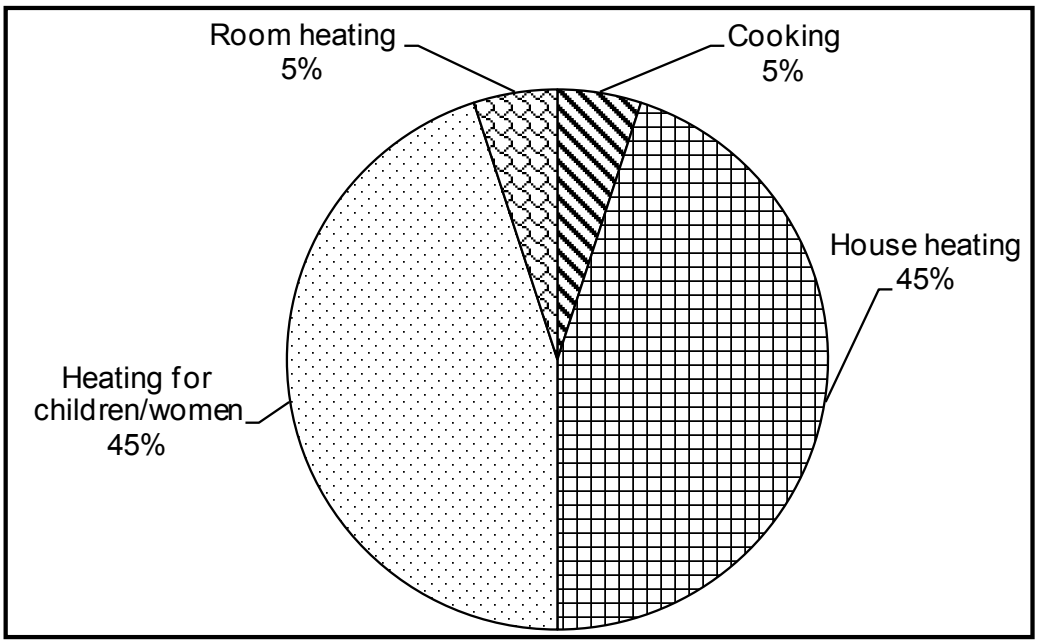

Fig. 5 . Bio-briquette consumption pattern

atmosphere. Such exchange of carbon between geological formations and the atmosphere is a significant part of the world carbon cycle.

There are highly fragile and weak rocks in the Siwaliks of Nepal and are highly degraded because of concentrated extreme rainfalls as well as high rate of deforestation for fuelwood. This has also increased the frequency and size of disasters like floods and landslides. This trend is also applicable in the Lesser Himalaya and the Higher Himalaya as the rocks are highly deformed and the topography is quite steep. Forest soils and many of the sedimentary rocks constitute a large portion of carbon and releases of carbon from these, caused by deforestation, can significantly increase the concentration of GHGs in the atmosphere. Deforestation and forest degradation are the second largest anthropogenic source of carbon dioxide to the atmosphere, after fossil fuel combustion, with about 20% of global anthropogenic CO_2 emissions (Van der Werf et. al 2009). Production and use of bio-briquette in a mass scale has three fold benefits of reducing natural disasters, preserving geological sequestration of CO_2 and less emissions of CO_2.

CONCLUSIONS

Bio-briquette is quite useful and suitable form of energy from the environmental, cleanliness, income generation, employment, health, efficiency and time savings point of views. Its promotion is even more important in order to address climate change by reducing GHG emissions and preserving natural carbon sinks as well as geological sequestration of CO_2. In the context of Nepal where the rocks are highly deformed and fragile, there are extreme rainfall events and the deforestation for the fuelwood is in increasing trend, production and consumption of bio-briquette can be quite useful to save the forest, reduce the water induced disasters and preserve geological sequestration of CO_2. However, dissemination of knowledge and information is presently inadequate and it should be made easily available in the rural communities. Since there is presently no convenient methods to correctly compare GHG emission from briquette and fuelwoods, more research is required. Importantly, joint efforts are necessary to promote bio-briquette both from alternative energy and climate change mitigation perspectives.

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Watershed management: Issues and approaches in Nepal

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ABSTRACT

Nepal has sharp physiographic and climatic contrasts despite its small area. It has several watersheds ranging from big basins to micro-watersheds of the smallest size. Many of these watersheds are in a state of physical and biological deterioration, due to overexploitation of natural resources. Watersheds of the Siwalik region are more geologically fragile, erodible and are deteriorating fast due to population pressures. While there is very old tradition of watershed management (e.g, terracing) watershed degradation and its consequences were realized by Government of Nepal only about four decades ago. To combat the problems institutionally a separate Department of Soil Conservation and Watershed Management has been established under the Ministry of Forest. At present watershed management activities are extended to 73 districts of Nepal. There are many issues related to efficient watershed management in different ecological zones. Due to their unsuccessful history top-down and bottom-up approaches are replaced by participatory approaches to watershed management.

INTRODUCTION

The importance of watersheds as ecological units in the context of natural resource management and conservation cannot be overstated. They are hydrologic units that are often used as biophysical and socio-economic or political units for the planning and management of natural resources (Brooks et al. 1991). A watershed is a topographically delineated area that is drained by a stream system, i.e., all of the land draining its rain, snowmelt and ground water into a stream or river (Swallow et al. 2001).

Nepal is situated in the central Himalayas and has several watersheds ranging from big basins to micro-watersheds of the smallest size. Three major rivers, Sapta Koshi in the east, Karnali in the west and Sapta Gandaki in the middle drain Nepal. Nepalese rivers are classified into three different classes. Rivers in class I category originate from the high Himalayas. They are always full of dry season flow because of melting of ice. The class II Rivers originate from the slopes of the Mahabharat Mountains. They also have some discharge of water because they start from permanent sources of water such as springs, waterfalls and other sources of water. The class III Rivers originate from the Siwalik and the southern slopes of the Mahabharat Range. They get dry during the dry season since they flow only from the monsoon rainfall. There are more than 6000 such rivers in Nepal. The total drainage of all these rivers covers an area of 194,471 km^2, of which 45.7 % lies within Nepal (Uprety 2006). Many of the watersheds are in a state of physical and biological deterioration due to overexploitation of watershed resources by the inhabitants.

In Nepal, awareness of watershed degradation problems as well as their consequences was realized about four decades ago. For the first time, in 1967, Government of Nepal (GoN) received assistance from the United Nations Development Program /Food and Agriculture Organization (UNDP/FAO) in the field of watershed management, and the Trisuli Watershed Project was implemented from 1967-1970. The torrent control component of the project was continued till 1973. Later on, GoN decided to resolve the watershed degradation problems through institutional development. In this context, a separate Department of Soil and Water Conservation was established in 1974 within the Ministry of Forests. In order to develop the capability of this newly established department, a second project called the Integrated Watershed Management, Torrent Control and Land Use Development became operational initially in Phewa Tal Watershed from 1977 and undertook a nation wide reconnaissance inventory of major ecological land units and their watershed conditions. This inventory identified that one third of nation's watersheds lie under critical conditions. Several other projects also became operational within a period from 1974-1977 (Wagley 1995).

In 1980, GoN transferred the Department's responsibility for flood control to the Department of Irrigation and it was renamed as the Department of soil Conservation and Watershed Management (DSCWM), to better represent its roles and responsibilities of watershed management. Until 1988, the Department had three central level projects covering 5 districts, eight district level projects covering 21 districts and three national level projects on Watershed Management, Remote Sensing and Environmental Impact Study (Wagley 1995).

In 1993, the Department was reorganized and renamed as the Department of Soil Conservation (DOSC). At present DSCWM is providing SCWM service to 73 out of the 75 districts of Nepal through 56 District Soil Conservation Offices (DSCO). The donors and agencies involved in the soil conservation and watershed management programs include the Asian Development Bank, CARE International,

Danish International Development Agency (DANIDA), German Organization for Technical Cooperation *(*GTZ*),* Japan International Cooperation Agency (JICA), United States Agency for International Development (USAID) and UNDP/FAO.

Traditionally watershed management systems had been focused on terracing, control of shifting cultivation, relay and mixed cropping, grazing in forests and in open grounds, and retaining some trees on upland terraces. However, at present, DSCWM has been planning, implementing and monitoring soil conservation and watershed management programs/activities based on the principles of integrated watershed management.

ISSUES ON WATERSHED MANAGEMENT

There are lots of issues on soil conservation and watershed management. The prominent issues broadly identified so far arise in the following fields.

Conceptual
Institutional and organizational
Technical
Management
Investment
Participation

Conceptual issues

The concept of scientific soil conservation and watershed management has emerged only recently and there is still confusion about its concept and scope. Watershed management should not be confused with forestry, agriculture, upland conservation, integrated land development only when carried out in a catchments area.

Institutional and organizational issues

There is an institution namely Department of Soil Conservation and Watershed Management under the forest and soil conservation ministry of GoN. However, organizational development of the department is not adequate to tackle the ever-growing problems of watershed degradation. The services rendered by the department have not yet reached all the districts of the country. The organization requires a central coordination section, which can establish interdepartmental coordination at all levels to minimize duplication of efforts and to promote effective execution.

Technical issues

Most of the watershed management professionals in Nepal are trained overseas using a highly technical and research oriented curriculum. Nepal's watershed management problems, however, demand specific technologies to suit its geological conditions, topographic variations and climatic diversification: these technologies are still being developed. The scarcity of reliable income generating technologies is a prominent issue. Indigenous technology has not been identified properly, so that much new technology has been inappropriately applied.

Management issues

Management issues to watershed management are necessary to discuss in central, district and local level. In the centre staffing is not designed to cope with the needs of the multidisciplinary team, though it is in progress. Coordination among the line agencies is quite weak. Frequent transfer of technical staff from duty stations both at the center and in districts has also hampered the watershed management programs. At the users' level there exist a number of management problems such as record keeping, maintaining accounts, report writing and correspondence.

Investment issues

Soil conservation and watershed management is a long term process, which requires long term investment. District Soil Conservation Offices have been gradually opening in several districts, but investments in and strengthening of central units to support planning, extension and training, monitoring and evaluation has not been commensurate with the additional demands placed on them.

Participation issues

People's participation has been highly emphasized in the soil conservation and watershed management sector with the evolution of several different models over the past two decades. However, resource related attitudinal and withdrawal issues are far from public decision. Gender, ethnic and minority groups related issues have only recently been addressed.

The major issues, which relate to the working strategies and operational procedures of important activities, are as follows.

Program planning and implementation.
Monitoring and evaluation.
Extension and education.
Research and demonstration.

Program planning and implementation

Systematic program planning is essential for successful soil conservation and watershed management. But in Nepal, deficiencies in the program planning system have seriously hindered the successful implementation of the activities. Programs are superficial that don't consider the socioeconomic and cultural factors. They are launching without pre-determined objectives. Ignorences of indigineous knowledge, lack of proper methods to include the socio-economic and cultural aspects are other factors. Implementation is generally overlooked while preparing plans. Also there are not well-defined and suitable models of watershed management; too many models developed by

different donor-assisted projects create lots of confusion.

Monitoring and evaluation

The monitoring and evaluation systems so far developed have not been designed to measure the quality of work. They are useful only for measuring the volume of work done. The useful indicators that would help in choosing the most relevant program for different localities have not been adequately identified. The guidelines for reliable data collection are lacking, so that monitoring of social and cultural factors although being important are in backward position. Until now, monitoring and evaluation has been regarded, as the responsibility of central organizations only and it has not been used systematically in district activities.

Extension and education

Soil conservation and watershed management encompasses multi-disciplinary and multi- sectoral approaches. So extension education aspect is very important. The extension section in DSCWM is too small to deal with the wide range of extension activities, which are needed to reach large numbers of widely spread target groups. The extension activities are carried out without good strategies and plans. The extension program has focused only on awareness generation. No effort has been made to promote the adoption of technologies through extension education.

Research and demonstration

Although watershed management activities are increasing, appropriate research and demonstration efforts are not keeping place. A few demonstration plots have been established on the initiative of the DSCWM but none of them are well maintained. Knowledge of the technical relationship between soil conservation and watershed management practices and their effects and improved ways of identifying and quantifying social values and benefits, is very poor.

The linkages between appropriate research, demonstration and extension and education are also weak.

APPROACHES TO WATERSHED MANAGEMENT

Since the inception of watershed management concept during the early 1970s, the approach to resource management in Nepal consisted of top-down planning, implementing and monitoring of activities. Available maps and aerial photos were used to assess land and forest resources. Targets were fixed based on available budgets. Terrace improvement programs were administrated as individual farm activities, and other activities were planned for public land based on project quotas (Ohler et al. 2000). These types of activities, mainly focused on engineering work, were expensive for construction and maintenance (DSCWM 2004). The conventional top-down approach was ineffective due to overlook of the local knowledge, traditional practices, socio-economic conditions and available resources. Target oriented top-down approach was not very successful for watershed management, but it has some strengths. Experience has shown that centralized 'top-down' conservation is only effective with large expenditures allocated for enforcement or under autocratic governance (CIESIN 2004).

The bottom-up approach involves decentralization of planning and policy formulation which has become popular because it includes the democratic process of participation of the local people for planning, implementing and decision making for community development at the local level.

Contrary to the earlier approach, bottom-up planning is encouraged later for ensuring farmers participation so that the watershed management programs can be sustainable. Community mobilization is done for demonstrations so that people can replicate them by their own efforts.

The approach to people's participation in watershed management in Nepal has been evolving since 1974 (Sharma and Wagley 1996). Its evolution can be divided

Table 1: Watershed management approaches adopted in Nepal (Ohler et. al. 2000)

Year	Approaches	Activities
1974-1900	Central level planning (top-down)	Project based activities conducted by construction companies or hired labor
1981 - 1995	Initiation of decentralization	Key persons or local leaders were taken into consideration in the project implementation process
1986 - 1990	In line with decentralization	VDC, DDC and DSCO on project implementation were taken into consideration in planning process, user groups were established Started to handover community forestry
1991 - 1994	Bottom-up approach and people's participation	Sub watershed planning was institutionalized. Most activities were implemented through users. RRA, PRA techniques came into use to collect socio-economic data
1995 onwards	Institutionalization of participatory approach, watershed boundary to political boundary	Gender and social equity consideration, rights and access to community resources for local communities, indigenous knowledge integrated into new technology approach. User groups formal registration; the link between UG and VDC became more formal

into four stages. In each stage people's participation has been described in terms of a five-part project cycle: watershed resources assessment; project activity planning; implementation, maintenance, follow-up and benefit sharing; and extension efforts. But in the absence of legal framework for people's participation in the past, influential persons attempted to obtain all the benefits of a project's activities in the name of community participation (Sharma and Wagley 1996). People's participation in watershed management has gradually increased after the Decentralization Act in 1982 and it has been institutionalized since 1991.

Nepal is a leading country in community based natural resources management in South Asia. Peoples' participation is mandatory in government policy in all natural resource management programs (Tiwari 2008). The participatory approach has empowered local people to take active decisions and responsibilities at the local level in natural resource management. Nowadays participatory watershed management is becoming a focal program in Nepal.

CONCLUSIONS

The major issues on watershed management are being addressed by adopting bottom-up and participatory approaches to manage the watersheds from micro-level to macro-level. Details mechanisms of community participation has been developed and implemented. Most of the projects are based on experimenting and demonstrating various innovations of improved conservation practices for enhancing the local's feelings and enthusiasm in a participatory approach to soil conservation and watershed management.

The soil conservation and watershed management program is a farmer's program. So people participation is appreciated nowadays; however effective participation of ethnic, minority and backward groups is lacking. Traditional practices of conservation have been practicing for centuries effectively. Thus, indigenous technology for conservation of natural resources should be critically identified before putting external technologies in resource conservation tasks. Although demonstration, extension and education programs are launching in different project sites it is necessary to make them more effective in generating farmers willingness and awareness about conservation activities.

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Application of statistics in geological sciences

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ABSTRACT

This paper attempts to appraise the importance and scope of statistical modeling in geological sciences and also explains the use of computer and test statistic in the analysis of geological data. Geological sciences provide a host of case studies for the use of statistical techniques. The computer has become essential tool for geological research and it has become a tool for simulations as well. There are several models developed for modeling the geological sciences researches and that might be provided the linking of statistics, probability, and computer modeling in the recent days. There are several test statistic developed in testing the observed geological data. The test statistic has an important and significant contribution in the analysis of geological data.

INTRODUCTION

Probably contemporary geology was founded at the end of the 18th century as an observational, descriptive, qualitative, and subjective science. There was the pioneer work in statistics with the application of agriculture, biology, medicine, geology and psychology are of the more examples, which led to the first major roadmaps of quantitative techniques in geological sciences - and the models were used in all branches of geological sciences (Agterberg1974; Aryal 2011a). After 1950, the period of greatest growth of quantitative techniques in geological sciences occurred when it was discovered that both statistical and multivariate techniques could be used on the computer and could therefore be applied for the enormous quantity of geological related numerical data.

There are many ways of describing the statistical modeling process itself, but as used in geology, it tends to follow some stages (Rogerson 1988; 1989a; 1989b). These stages are: data acquisition and sampling; data mining / organizing/ analysis; hypothesis testing; prediction, etc. Not all of these stages are seen in the use of statistical models, but perhaps the most vital aspect of the quantitative approach is that it highly conditions the initial stage of data collection. We do not collect and organize data in a random way - the world is too full of information for this to be effective in the scientific sense and therefore we start from a pre-defined and narrow interpretation of those facts we are interested in collecting (Rogerson1989a). There is already an implicit hypothesis to be tested which the collected data helps us to resolve. Thus the above cycle could just as easily start with the hypothesis to be tested. The concept of the hypothesis defines the relevant facts, which are then sought in the geological world. Thus this paper attempts to appraise the importance and scope of statistical modeling in geological sciences, data analysis through computer and test statistic in geological data.

STATISTICAL MODELING IN GEOLOGICAL SCIENCES

The application of statistics and probability to geological sciences in general serves one of two conceptually different purposes. Since real-world data is usually too numerous and/ or too complex to be easily comprehended, we therefore may use statistical models to effectively reduce the information to a more representative or manageable form. For instance a set of measurements is replaced by their mean and variance of the observed phenomena. Statistical models may be used contradictorily as to apparently increase the data by using interpolative or extrapolative models on limited sets of data. For example curve and surface fitting models are widely used in geological sciences to replace a finite number of known values with an infinite or continuous set of data, which may not even include any of the original data that either discrete or continuous in nature.

In statistical analysis, original data are replaced with a model which is easier for us to understand, visualize, or manipulate, even though the model appears to carry less (or more) information. Statistical model can provide precise and concise results that have a meaningful interpretation and make proper decision (Aryal 2012). Such types of model occur frequently in statistics when we replace finite samples by their mean and variance or less information if exists or by a particular continuous distribution with the same mean and variance or more information if exists. In a basic sense, the process of statistical modeling becomes a delicate

conversions of information through numerous stages of data collection in the geological sciences, analysizing them, and modeling those data, in which the analogy of a statistical modeling refinery is probably more informative than that of raw and scattered data. For instance, in the context of petrology and geochemistry, an extensive statistical technique is used to analyze the geological data such as mineral or chemical composition of rock samples. An interesting uncertainty is appeared during a way of sample selection and collection of data and there was a chance of unbiased sampling, sample errors and non sampling errors that may exist in the data so far that have been colleted.

A sample is defined as the eye of a statistician that sample is a number of objects taken from a population, whereas a sample is defined as the eye of a geologist that sample is usually a single object or specimen and so on (Aryal 2011a). The rule of selecting a sample by keeping in mind to avoid bias in the sample, which the sampleshould be chosen at random, so that each and every object in the population has an equal chance of being collected, but there are several issues that the human tendency to collect peculiarities is revealed by the usual rock collection by geologist, which contains more strange than common rocks. Once the rock samples have been collected and measurements made of their chemical composition, the process of statistical modeling begins with using assumptions. Computation of descriptive statistics, such as the mean and standard deviation for values, of a particular chemical is useful in replacing the data with a central value and a measure of the deviation from the central value. These two statistics can then be useful for study and comparison with other samples from the same or different populations. From the data we can make observations about the variability in measurements, a factor which must be taken into account in all geological modeling. In particular, it is pointless to use highly sophisticated and delicate statistical models on data whose accuracy or reliability is low. This illustrates the importance of general principle relating to the data in its geological context at all stages in the modeling process. The extensive geological data leads to modeling using many kinds of probability distribution, including the binomial, Poisson, and log-normal and many other distributions.

There is another typical problem in geological sciences is the visual or mathematical representation of a finite number of data points as a continuous curve or surface in space. When the collected data on the distribution of minerals, ores, or chemicals in the earth, this can be represented using three-dimensional coordinates 'say' x, y, z, which lead us try to find out a model function 'say' f = f(x,y), which is a good fit or even, according to some criterion, a best fit for the data points that we used. Many geological situations produce coordinate data points for which it is useful to find interpolated or extrapolated values - the real problem is to decide which function f = f(x,y) should be used to fit the data points. It was realized that sophisticated models may be needed (Aryal 2011b; Davis 1981). No doubt there is an infinite range of possible functions in the modeling process; however, we usually resolve the best-fit problem by choosing some criterion of minimal curvature and relating to the issues that have been studied as it is the special case.

STATISTICAL MODELING OF GEOLOGICAL DATA THROUGH COMPUTER

In geological sciences, the computer is used when the data and/or the necessary calculations are numerous, when we need to control and manipulate a database relating to geological sciences, when we wish to apply complicated mathematical formulae, and when we wish to model using a simulation that must be repeated a large number of times such as Monte Carlo methods. It is, however, one thing to realize that geological sciences related problems can be solved using the computer programming, and also to write a program that will work data friendly, which may help to produce better results. In these days, we have found several readymade packages for computing and analyzing data from the computer. There are several practical difficulties and limitations remind with analysts that the computer is far from being a miracle machine that always makes our life easier in several dimensions. The formulation of more sophisticated statistical models and simulations is highly complex so as the results the demands for computer applications among geologists continue to increase day-by -day.

In statistical based probability modeling, geologists are confronted not only with stochastic or deterministic or time-independent models, but more and more frequently are using markovian processes and even more uncertain models, of which the general random walk is perhaps the most well-known use in the geological sciences. It was realized that some random elements do enter many geologic phenomena and therefore the computer is essential for statistical modeling for long-run simulations by varying numerical parameters of the geological data (Merriam 1976). A typical illustration of modeling that occurs by using the computer to convert assay variation or drill hole data into a three-dimensional space-filling function as studied by Merriam (1978). This may be imagined as a series of three-dimensional contours from which two-dimensional sections can be extracted by the computer methods. The irregular data was located at three-dimensional coordinate points. It is clear that the extensive use of statistical techniques through the averaging, relocating, and smoothing functions is not possible without the aid of the computer to effect the calculations, and also to retain in its memory the final space function model of the

original data. Nowadays many (if not most) statistical and probabilistic models used in geology are implemented using a computer.

In the area of paleontology, the computer has taken its place with the microscope and hand lens as a basic research tool, leading to a search for general statistical laws, aided by the computer catalyst without which it would be impossible to treat the markovian processes involved in an enormous data analyzing (Merriam, 1981). For instance, the record of volcanic activity in New Zealand is one of the examples to attempt the model for the repose period patterns of volcanoes (Meman, 1976). The next example is the markovian models to simulate different stages of volcanic activity by using simple transition parameters for the probabilities of passing from one state to another. The models are computer-simulated and the parameters varied to produce an effect similar to that obtained in reality. It is therefore a computer is essential to model for the long-run trials involved in geological sciences.

TEST STATISTIC IN GEOLOGICAL SCIENCES

In a practical and critical rationalism, researchers and scientists should formulate falsifiable hypotheses rather than producing ad hoc answers to empirical data in various observations, which mean to predict and test rather than merely to explain the phenomena (Popper 1959). There are several statistical tests like Chi-square test, t-test, or Kolmogorov-Smirnov test or run test, median test and many more other parametric as well as non-parametric tests (Aryal 2011a). In realizing the importance of statistics, most of the graduates students studying should need the course of applied statistics including descriptive statistics along with mean, median, mode, partition values, dispersion, standard deviation, skewness, kurtosis, random variables, correlation, regression, multiple regression, concept of probability and probability distribution, concepts of parametric and non-parametric statistics, t-test, z-test and Chi square test, Bernauli trails, binomial distribution, Poisson distribution, normal distribution, inferential statistics, estimation for mean, proportion, sample size determination, hypothesis testing for mean and proportion, non-parametric test, test of goodness of fit, Sign Test, Mann-Whitney U test, Kruskal-Wallis H test. In addition to these, students and researchers must have the knowledge of advance statistical techniques in order to do geological researches.

These statistic tests are used to make deductions more objective and statistical tests have been used in a wide range of geological disciplines including geochemistry, geophysics, hydrology, earth sciences and geochronology, and others disciplines as well (Sircombe and Hazelton 2004; Reimann and Filzmoser 2000; Anderson and Johnson 1999; Lørup et al. 1998). However, it is important to note that statistically significant is not the same as geologically significant. This fact will be illustrated with a geophysical example, in which (let us say) Pearson's Chi-square test implies that earthquakes are unevenly distributed throughout the week, with seismic activity being particularly high on particular day.

Theories relating to test statistic can be tested by formulating a null hypothesis (H_0) against an alternative hypothesis (H_a), which can be either two-sided test or one-sided test. For instance, the null hypothesis is that an average global temperature has remained constant since 2000 against an alternative hypothesis is that an average global temperature has changed since 2000, which is considered to be the two sided test. Similarly, the null hypothesis is that an average global temperature has risen since 2000, which is considered to be one-sided test. Let us take a quantitative data set of a time series of temperatures as the data either in months or days or hourly, the decision whether or not to reject null hypothesis (H_0) in favor of alternative hypothesis (H_a) is made on the basis of test statistic. The test statistic is unlikely to occur under null hypothesis (H_0), and then null hypothesis (H_0) is to be rejected and otherwise accepted. The probability of observing a value at least as extreme as test statistic under null hypothesis (H_0) is called the p value, and a cut-off value of p is taken as 0.05 and that is often used to make a decision on a 95 per cent confidence level.

There is a problem with the approach of test statistic is that it lumps together two factors and the first factor is the effect size and second factor is the sample size (Aryal2011a). Given a huge data set, statistical tests will pick up any departure from the null hypothesis, no matter how small the data set. The result is that geological hypotheses are never true—they will always be rejected if lots data are available. To illustrate this question, we consider the notes on seemingly plausible null hypothesis that the occurrence of earthquakes does not depend on the day of the week. If we test such type of hypothesis, we need to take a global database of earthquakes. The earthquakes were tallied by weekday, resulting in a seven-bin histogram with bin counts varying between all the days of the week. The null hypothesis is statistically equivalent to saying that the histogram is uniformly distributed as plotting the data or that may also not equally distributed. If uniformly distributed, then it is suggested that a Chi-square test was used to evaluate the statistical significance of the observed scatter and the departure from uniformity in the earthquakes data. As given a set of expected and observed events of earthquakes data, we use Pearson's statistic, which can be shown to follow

a Chi-square distribution with fixed degrees of freedom (Aryal, 2010). For the earthquake database, the test statistic is then obtained. The likelihood of observing a result that we get from test statistic and compare to the tabulated value of Chi-square and to make an inferences and thereby proper decision with the help of the p value that may rejected or accepted. Finally, based on the test statistic researchers interpret the results and make appropriate decisions. In similar manner, we can use other test statistic for geological data.

CONCLUSION

Geological sciences provide a host of case studies for the use of statistical, probability, and computer models covering representational and parametric and non-parametric statistics, stochastic and deterministic, and markovian processes, random walk, queuing models, and Monte Carlo methods, etc. For most of these applications, the computer has become essential for the storage and manipulation of data as well as for the rapidly developing and innovative field of computer modeling through simulations. Not only do the earth sciences provide a rich resource of examples for statistics and probability courses, but they also provide an example of the power and mutual benefit of linking statistics, probability, computer modeling in a modern day experimental science especially geological sciences. There are several test statistic developed in testing the observed data in geological sciences. The test statistic has an important and significant contribution in the analysis of observed phenomena in order to predict and to make decision quickly.

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भू–गर्भ विज्ञानमा दर्शनका केही पक्षहरू

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सारांस

यस लेखमा भू-गर्भ विज्ञानको विकासक्रम झल्काउने सन्दर्भमा पूर्वीय तथा पाश्चात्य दर्शनका केही प्रमुख प्रभावहरू समेटिएको छ। मानव सभ्यता सँगै धेरै दार्शनिक तथा वैज्ञानिकहरूको अथक प्रयासवाट भू-गर्भ शास्त्र आजको उचाइमा पुग्न सफल भएको हो। यस विज्ञानले विभिन्न कालखण्डमा जन्माएका प्रविधिहरूको प्रयोगले मानव जातिको विकास युगानुकुल नयाँनयाँ कोणबाट अगाडि बढ्दै आएको हो। प्रविधिहरूको अत्याधिक प्रयोगले वर्तमान समयमा एकातिर खनिज सम्पदाहरू रित्तिदै गएका छन् भने अर्कातिर प्राकृतिक वातावरणमा प्रतिकूल असरहरू देखिएका छन्। यिनै प्रमुख समस्याहरूको दीर्घजीवि समाधान गर्नु नै आजका युवा भू-गर्भविद्हरूको चुनौती रहेको छ।

विषयप्रवेश

आजको सम्पूर्ण भौतिक सुविधाको निम्ति निर्माण भएका प्रविधिहरू विज्ञानका देन हुन्। विकासका लागि नभइ नहुने विज्ञानका विभिन्न क्षेत्रहरू मध्ये भू-गर्भ विज्ञान (geology) पनि एक महत्वपूर्ण विषय हो। यो विज्ञानको सम्बन्ध अन्य सबै विज्ञानसँग नङ र मासुको जस्तै छ। त्यसैले विश्वका प्रायः सबै मुलुकहरूमा यो विज्ञानको गहन अध्ययन, अनुसन्धान र प्रयोग हुँदै आएको छ। भू-गर्भ विज्ञानमा पृथ्वीको समष्टिगत (holistic) अध्ययन गरिन्छ। विज्ञानका हरेक विधासँग सबन्धित भू-गर्भ विज्ञानको विकासक्रम र क्षेत्र विस्तार कसरी भयो, यसको बिकासमा के कस्ता दर्शनको प्रभाव पऱ्यो र आजको यो आधुनिक युगसम्म आइपुग्यो भन्ने जिज्ञासा सर्वसाधारणदेखि दर्शन, साहित्य तथा विज्ञान र प्रविधिमा रुचि राख्ने सबैका लागि साझा रहन सक्छ। विज्ञानको क्षेत्रमा आएको दर्शन र अन्य क्षेत्रमा विद्यमान दर्शनको बीच पनि अन्तरसम्बन्ध देखिन्छ। यस लेखमा विद्यमान दर्शनका बीच भू-गर्भ विज्ञान कसरी अगाडि बढ्यो, यसमा पूर्वीय तथा पाश्चात्य दर्शनको के कस्तो प्रभाव रह्यो, अन्य विज्ञानका क्षेत्रबाट कसरी यो छुट्टै पहिचानका साथ देखा पऱ्यो र यो विज्ञानमा कालखण्ड अनुसार के कस्ता धारणाहरू जन्मिए र अस्तित्वमा रहे, यो विज्ञानलाई अग्रता प्रदान गर्न कस-कसको योगदान उल्लेखनीय छ जस्ता जिज्ञासाहरूलाई मुख्य बिन्दु बनाएर यो लेख तयार गरिएको छ।

पृष्ठभूमि

कुनै पनि ज्ञानको गहिराइतर्फको यात्रा नै दर्शन हो। दर्शन जिउने प्रक्रियामा सत्यको सत्अन्वेषण हो। जीवनमा प्राप्त अनुभूतिहरूको आधारमा बुद्धिको माध्यमले गरिएको अन्तिम सत्यको खोजी नै दर्शन हो। हाम्रा पूर्वजहरूका थुप्रै दर्शन र अभ्यासबाट हामी आजको आधुनिक युगमा आइपुगेका छौं। दर्शनको उत्पत्ति र प्रयोजनको सम्बन्धमा पूर्वीय एवं पाश्चात्य विद्वानहरूबीच मतभिन्नता पाइन्छ। त्यसैले दर्शनको परिभाषा दिँदा र व्याख्या गर्दा दुवै दृष्टिकोणबाट विचार गर्नु उपयुक्त हुन्छ।

पूर्वीय दर्शन

संस्कृतका ग्रन्थहरूमा 'जसद्वारा जड र चेतनको सूक्ष्मभन्दा पनि सूक्ष्म तत्वलाई केलाएर देखाइन्छ, त्यसलाई दर्शन भनिन्छ'। अर्थात् '**दृश्यते चिदचित्सूक्ष्मतत्त्वमनेनेति दर्शनम्**' भनी दर्शनलाई परिभाषित गरेको पाइन्छ। वेद नै पूर्वीय दर्शनको पहिलो प्रामाणिक पुस्तक मानिएको छ। यो १५०० देखि १२०० ई. पू. सम्मको रचना हो भन्ने कुरामा धेरै विद्वान सहमत भएका छन्। वेदको अर्थ ज्ञान हो। **जडबाट भगवानले चेतना उत्पन्न गराउनु भयो** र सृष्टिको क्रम शुरु भयो भनी वेदमा बताइएको छ। यो ज्ञान ईश्वर बारेको ज्ञान हो। त्यस बखतका महर्षिहरूले ईश्वर देखे। संसारको सृष्टिमा ईश्वरको हात भएको कुरा स्वीकारे। सुख शान्तिको लागि भगवानको प्रार्थना हुनुपर्दछ भन्ने कुरा बताए। त्यसबखतको मानव जातिले यो सोच अगाडि सार्नु नै ज्ञानको ज्योति बाल्नु हो। यसरी मानिसलाई यो अनौठो सपना बाँड्न सफल भए महर्षिहरू। यो पनि एउटा क्रान्ति नै थियो। भगवानका तपस्याबाट सृष्टि प्रारम्भ भएको व्याख्या गरिएको छ। यसरी वेदमा सृष्टिबारेको चिन्तन प्रस्तुत गरेको **जनक दर्शन** भन्ने पुस्तकमा उल्लेख गरिएको छ (गिरी २०५५)। हुन त वेदका मन्त्रहरू मूलतः प्रार्थना नै हुन् तर पनि यसलाई ज्ञान, उपसना, कर्म र प्रार्थना काण्डको रूपमा विभाजन गरिएको छ। अथर्ववेदलाई ज्ञान काण्ड, यजुर्वेदलाई कर्म काण्ड, सामवेदलाई शक्ति काण्ड र ऋग्वेदलाई प्रार्थना काण्डमा राखिएको छ (अधिकारी २०६७)। वेदपछि उपनिषदहुँदै महाकाव्य र पुराण युग (ई. पू. ९९ देखि २०० सम्म) देखापऱ्यो। यो समयमा लेखिएको रामायण, महाभारत, पुराण, स्मृति आदि पुस्तकहरूमा उपनिषद्ले स्थापना गरेका दर्शनहरूको व्याख्या गर्ने काम पूरा भयो। यी महाकाव्यहरूमा सयौं कथा भनेर, अनेकौं उदाहरण दिएर मानिसलाई सत्मार्गमा लाग्न प्रेरणा दिइएको छ। यसै समयमा अवतारवादको सोच अगाडी आयो। राम, कृष्ण, बुद्ध आदिले अवतारको मान्यता पाए। यसै समयमा लेखिएका अठार पुराण र अठार उपपुराण पनि मानिसलाई सत्मार्गमा लैजाने आधार बनेका छन्। साङ्ख्यको सत्कार्यवाद, न्यायको असत्कार्यवाद, योगको योगाभ्यास, वेदान्तको अद्वैतवाद, बौद्धको विपश्यना, जैनको स्यात्वाद र चार्वाकको भौतिकवाद यी सबै एकदमै अनौठा सोचहरू हुन्। यी सबै अनौठा सोचहरू भारतवर्षमै जन्मिए र गङ्गाको मैदानमै हुर्किए। सारांशमा बुझ्दा पूर्वीय दर्शनहरू प्रायः अध्यात्मवाद सँग सम्बन्धित देखिन पुगेका छन्।

पाश्चात्य दर्शन

ज्ञानप्रतिको प्रेम भन्ने सोचबाट सुरु भएको पश्चिमी दर्शन अध्यात्मशास्त्रसँग मात्र सिमित भएन। अहिलेसम्म प्राप्त जानकारी अनुसार युनानमा जन्मिएका थेल (६२४-५३४ ई. पू.) लाई पहिलो चरणका दार्शनिकहरू मध्ये राखिन्छ। उनी सुकरात भन्दा पहिलेका

दार्शनिकहरू मध्येका दार्शनिक हुन् । उनले पानीलाई सबै कुराको मूलतत्व मानेका छन् । थेलपछि देखापरे अनक्सिमन्दर (६११-५२४ ई. पू.) । उनी अणुवादी बनेर देखापरे । उनले भने, **हामीले देखेका सबै ठूला कुराको वीज तत्व एकदमै सानो छ, त्यही सूक्ष्म तत्वबाट स्थूल तत्व उत्पन्न भएको हो** । युनानीहरू कुन देवताले के बनायो भन्ने तर्फ लागेनन् । त्यो कुरा कसरी बन्यो तर्फ लागेको देखिन्छ । त्यसैले पश्चिमी दर्शनबाट वैज्ञानिक सोचको विकास भएको देखिन्छ । त्यस बखतको युनानमा एउटा अर्कै खालको प्रतिभा देखापरे । ती थिए पाइथागोरस (५८२-५९३ ई. पू) । उनी गणितका ज्ञाता थिए । उनी सूक्ष्म तत्वलाई मान्थे । हरेक कुरा गणितकै सेरोफेरोमा अटाउँछ भन्थे । यिनले पृथ्वी गोलो छ भनी प्रमाणित गरे । हराक्लित (लगभग ५३७-५७५ ई. पू.) ले यो संसारलाई परिवर्तशील देखे र बग्ने पानीसँग तुलना गरे । उनको दर्शन बुद्धदर्शन जस्तै क्षणभङ्गुरवादी (प्रत्येक क्षण नाश हुने) देखापऱ्यो । यसरी सुकरातसम्म आइपुग्यो युनानी दर्शन । सुकरात भने सत्य-तथ्यको खोजमा दगुरे । सकभर प्रमाणको आधारमा विश्वास गर्नुपर्दछ, कहिलेकाहीं तर्कको आधारमा पनि तर लहैलहैमा विश्वास गर्नु मुर्खता हो भन्ने धारणा सुकरातको थियो । सुकरात पछिका महान दार्शनिक हुन् प्लेटो । "**प्लेटो का संवादहरू**" विश्वप्रसिद्ध पुस्तक हो । साम्यवादी शासन शैलीको सोच अगाडि सार्ने पहिलो दार्शनिक प्लेटो हुन् । उनीपछि ग्रीसको युनानमा महान दार्शनिक अरस्तु देखापरे । उनको दिमागलाई त्यस बखतको विश्वकोश भनिन्थ्यो । तर्कशास्त्र, दर्शनशास्त्र, भूगोल, प्रकृतिको इतिहास, मनोविज्ञान, शरीरविज्ञान, भौतिकविज्ञान, राजनीतिशास्त्र, आचारशास्त्र यी आदि के मात्र लेखेनन् अरस्तुले । यसरी पश्चिमी दर्शन परमात्मा र परलोकमा मात्र सीमित रहेन ।

अरस्तुपछि लामो समयसम्म पश्चिमी सोचले फड्का मार्न सकेन । जे थियो, त्यसैमा रमायो । यो समयलाई अन्धकारयुग भन्ने संज्ञा दिइएको छ । अरस्तु पछि जिसस क्राइस्ट देखापरे । बाँचुन्जेल नस्वीकारिएका उनका सन्देसहरू मृत्युपछि स्वीकार्य भए । तर यसलाई दर्शनको रूपमा लिइएन । इसाई धर्मप्रचारकहरू दर्शनलाई महत्व दिँदैनथे । उनीहरू केवल भक्तिवादी थिए । त्यसैले ज्ञानलाई महत्व दिएनन् । युनानी इसाई राजा जसवियनले ५२९ ई. मा दर्शन पढाउने सबै पाठशाला बन्द गराए । धर्मान्धहरू अगाडि बढे । उनीहरू कै जालमा पऱ्यो पश्चिमी दर्शन । बाइबल समाएर शोषण गर्न पल्केका मठाधीशहरूले नयाँ सोचलाई अगाडि आउनै दिएनन् ।

लामो समयपछि इटलीमा लियोनार्दो दा भिन्सी (१४५२-१५१९ ई) देखापरे । उनले चित्र बनाए, मूर्ति बनाए, वैज्ञानिक दस्तावेज तयार पारे । वायुयान बनाउन प्रयास गरे र नयाँ सोच अगाडि ल्याए । नयाँ सीपले मानिसको मस्तिष्कको ढोका खोले र पुनर्जागरणको थालनी गराए । यसै कालमा ग्यालिलियो ग्यालिलिले एउटा प्रयोग गरेर बाइबलमा लेखेको कुरा असत्य साबित गरिदिए । दूरबिन बनाएर आकाशका ग्रहमण्डल हेर्न सकिने अवस्था खडा गरिदिए । यसरी युरोपमा दर्शन र चिन्तनले नयाँ गति पायो । विज्ञानको प्रयोग र प्रविधिको विकासले मानिसको आँखा खोल्यो । यस बखत न्युटन (१६४२-१७२७ ई) जस्ता विज्ञानका चिन्तक देखापरे । नयाँ ढङ्गले संसार हेर्न र बुझ्न बाध्य बनाए । यो वैज्ञानिक दर्शनले संसार हल्लायो । धर्मको शोषणबाट छुटकारा पाउन नसके पनि भौतिकवादमा विश्वास गर्नेहरूको जमात बढ्दै जाने क्रम रोकिएन पश्चिम समाजमा । यत्तिकैमा कार्ल मार्क्स (१८१८-१८८३ ई) ले त समाजको पुनः संरचना हुनु पर्छ भन्ने कुरा उठाए । उनीहरू ईश्वर, आत्मा, स्वर्ग केही मान्दैनथे । सत्यको खोजी गर्ने, प्रमाणमा आधारित सिद्धान्तहरू जुटाउने र अधिकारको लडाइँ लड्ने लहडमा भिड्दै पश्चिमी समाज अगाडि बढ्दै गयो ।

विज्ञान र दर्शनको सम्बन्ध

दर्शनको सम्बन्ध धर्मसँग मात्र होइन विज्ञानसँग पनि छ । दर्शनले जस्तै विज्ञानका हरेक विधाले पनि ज्ञानमा रुचि राख्दछ र दर्शन जस्तै सत्यको खोजीमा सरिक हुन्छ । मस्तिष्कमा उत्पन्न जिज्ञासाहरूको समाधानका लागि जब मानिस बौद्धिकताको माध्यमले तर्क-वितर्क गर्न थाल्छ ऊ दर्शनमा पुग्छ भने जब उक्त जिज्ञासाको समाधान अवलोकन र प्रयोगबाट गर्न थाल्छ, ऊ विज्ञानमा पुग्दछ । यस अर्थमा दर्शन र विज्ञान दुवैको उत्पतिस्थान एउटै छ, त्यो हो जिज्ञासा । दर्शन र विज्ञान दुवैको विकासावस्थामा दुःख र आवश्यकताले महत्वपूर्ण भूमिका खेल्दछन् । मानिसको जीवनमा आइलाग्ने जन्म, प्रेम, मृत्यु, रोग, दुःख, धोका आदिले उसलाई भावुक बनाउँदछ । यस्तै भावनामा डुबेर शक्तिका लागि आध्यात्मिकताको बाटो खोज्छ । विज्ञानको जन्म पनि अभाव र त्योसँग सम्बन्धित लगाव सँग नजिक हुन्छ । विज्ञानमा कहिलेकाहिँ एउटा प्रयोगले यसको उप-उत्पादन (by-product) का रूपमा अन्य सत्यहरू पनि भेटिन्छन् । दर्शनले जस्तै विज्ञानले पनि सत्यकै खोजी गर्दछ तर उक्त खोजीबाट आउने प्राप्तिलाई अन्तिम भने मान्दैन । विज्ञानको खोजी अनन्त छ । दर्शन र विज्ञानबीच अध्ययन गर्ने तरिकामा भने केही भिन्नता छ । दर्शनमा दार्शनिकको सारा इन्द्रियहरू अध्यात्मतर्फ सक्रिय हुन्छन् भने विज्ञान कुनै एक समस्या लिएर यसको समाधानमा लाग्दछ । समस्या समाधान त दुवैको हो तर दर्शनले अध्यात्मको सहारा लिन्छ भने विज्ञानले परिक्षण र अवलोकन जस्ता प्रयोगात्मक विधिको सहायता लिन्छ ।

भू-गर्भ विज्ञानमा पूर्वीय दर्शन

पूर्वीय दर्शनका प्राय सबै पुस्तकहरूमा ईश्वर र धर्मका कुराहरू पाइन्छन् । भौतिकता वा विज्ञानतिर ध्यानै नगएको भन्न त मिल्दैन तर केन्द्रमा ईश्वर राखेर सारा सृष्टिदेखि मानव विकासको व्याख्या गरिएको छ । जुनसुकै ग्रन्थमा हेरे पनि यसको रचयिता मानिसले आफू बस्ने पृथ्वी र यसमा पाइने वस्तुहरूको कल्पना गरेकै छ । भगवानले कुनै एउटा ठूलो राक्षसको बध गरिदिँदा मासुबाट माटो, हाडबाट चट्टान र रगतबाट पानी बनेका कथा देखि लिएर पृथ्वीको उत्पत्तिको जिज्ञासा प्रायः सबै ग्रन्थहरूमा पाइन्छ । पृथ्वीलाई देवीको रूपमा ग्रहण गरिएको छ । यसको गर्भमा बहुमूल्य सम्पदा भएको पनि स्वीकारिएको छ । पृथ्वीको सम्बन्ध आकाश, चन्द्रमा, सूर्य र वायुसँग जोडिएको छ । भू-गर्भ विज्ञानले पनि यी सबैको साझा उत्पत्ति स्वीकारेको छ । पूर्वीय दर्शनभित्रको अवतारवाद आफैमा एउटा अनौठो चिन्तन हो । पूर्वीय ग्रन्थमा लेखिएका हाम्रा दश अवतारहरू हुन् :'**मत्स्यः कुर्मः बराहश्च नरसिंहश्च वामनः । रामो रामश्च कृष्णश्च बौद्ध कल्कि तथैवचः ॥**' भू-गर्भ विज्ञानमा अवशेषको अध्ययनबाट आउने प्राणीको विकासक्रमसँग अवतारवाद मेल खान जान्छ । जीवहरूको उत्पत्ति पानीबाट भएको विज्ञानले स्वीकारेको छ, जुन क्रमिक रूपमा माछा सम्म पुग्दछ भने अवतारवादमा पनि माछालाई पहिलो अवतार मानिएको छ । अनि क्रमशः कुर्म (पानी र जमिन दुवैमा बस्न सक्ने), वराह (पौराणिक मान्यता अनुसार दोस्रो अवतार मानिएको (जलचर) लाई क्रमशः पछिका अवतार मानिएका हुन् । यसरी पानी बाट पानी र जमिनमा बस्ने जीवको परिकल्पना आएको छ । वास्तवमा

चारौं चरणमा पुगेपछि मात्र हिन्दूहरूले एउटा विशेष खाले जनावर छुट्टिन लागेको सङ्केत गरेका छन् । नृसिंह अवतार (मानिस र पशुको छुट्टिने अवस्थाको मिश्रण) यसैको प्रतिक हो । यसरी अवतारवादले पाँचौ चरणमा पुगेपछि मात्र मानिसको पूर्णतालाई स्वीकार गरेको छ : वामन अवतार, एउटा फुच्चे प्राणी, मानिसको सङ्केतका रूपमा । त्यस पछि क्रमशः राम, परशुराम, कृष्ण जस्ता आर्दश बोकेका पूर्ण मानिसको रूपमा वर्णन गरिएको छ । यसरी हाम्रो अवतारवादी चिन्तन हाम्रो मानव विकासमा आधारित छ । वास्तवमा अवतारवाद भगवानको अवतार नभई मानव अवतार हो । मानव विकास प्रक्रियाको एउटा झलक हो । कल्की अवतारलाई अन्तिम अवतार मानिएको छ, जुन पृथ्वीमा हालको सभ्यताको अन्त्य हुने बेला देखा पर्ने कल्पना गरिएको छ । अहिलेको यो सभ्यताले विदा लिने र त्यसबेला मानव जातिको विनाश हुने कुरा पुराणमा स्पष्ट्याइएको छ । पृथ्वीमा प्रलय हुने कुरा लेखिएको छ । विज्ञानको चिन्तनबाट हेर्दा हाम्रो ब्राह्माण्डमा भएका सबै सूर्य, तारा, ग्रह, उपग्रहहरू पनि नाशवान छन् भनि स्वीकार गरिएको देखिन्छ । ताराहरूको जन्म र विनाशको व्याख्या भौतिक तथा खगोल विज्ञानमा प्रष्ट पारिएकै छ । पूर्वीय दर्शनमा आधारित स्वस्थानी व्रत कथामा समेत सबैको आयु हुने भन्दै ब्रह्माजीको आयु समेत सिमाङ्कन गरेको छ । यसप्रकार भू-गर्भ विज्ञानमा अनुसन्धान भएका पृथ्वी र जीवसँग सम्बन्धित तथ्यहरू पूर्वीय दर्शनमा पनि आध्यात्मिकता सित जोडिएर आएको पाइन्छ । आइन्स्टाइनका अनुसार उर्जाको सघन रूप नै हामीले देख्ने पदार्थ हो । पदार्थलाई विखण्डन गरियो भने यो उर्जामा परिणत हुन्छ । यहीकुरालाई शंकराचार्यले पनि भनेका थिए, **ब्रह्म सत्य जगत् मिथ्या** (अरुण २०१०) । सायद यिनै अध्यात्मिक चिन्तनबाट वैज्ञानिक चिन्तनमा रूपान्तरण हुन हाम्रा पूर्वज भू-गर्भविद्हरूलाई पनि पक्कै प्रेरणा मिलेको हुनुपर्दछ ।

भू-गर्भ विज्ञानमा पाश्चात्य दर्शन

पश्चिमी दर्शन ईश्वरीय लीलामा भन्दा मानव जातिको इहलीलाको खोजमा नै बढी रमाएको छ । बाइबलमा पनि पृथ्वीको उत्पत्ति र प्राणीहरूको अस्तित्वका बारेमा लेखिएको पाइन्छ तर वैज्ञानिक आधारको भने ज्यादै कमी छ । बाइबलको प्रमाण जुटाउने क्रममा भू-गर्भ विज्ञानमा नयाँ आयामहरू भित्रिन पुगेका छन् । भू-गर्भ विज्ञानलाई छुट्टै विज्ञानका क्षेत्रमा पहिचान गराउने काम पश्चिम मुलुकहरूबाट ईसाको चारौं शताब्दीमा Aristotle ले पृथ्वीको परिवर्तनको बारेमा उल्लेख गरेका छन् भने इटालीका लियोनार्दो दा भिन्सीले वैज्ञानिक दस्तावेज नै तयार पारेका छन् । उनले पहिलोपटक भू-गर्भसँग सम्बन्धित शोधको थालनी गरे । उनले उपत्यका बन्ने प्रक्रिया र चट्टान बन्ने प्रक्रियासँग नदीको भूमिका प्रस्टाएका छन् । यसप्रकार पश्चिमी सभ्यताबाट भू-गर्भ विज्ञानमा ठूलो योगदान रहन गएको देखिन्छ जसको क्रमिक वर्णन यसै लेखको पाचौं परिच्छेदमा समेटिएको छ ।

भू-गर्भ विज्ञानको विकासक्रम एक सिंहावलोकन

भू-गर्भ शास्त्रको इतिहास प्राकृतिक विज्ञान (Natural Science) सँग सम्बन्धित छ । भू-गर्भ शास्त्रको इतिहास खोज्दै जाँदा पहिलो चिन्तन प्राचीन ग्रीसमा पृथ्वी कसरी उत्पत्ति भए होला भन्ने प्रश्नसँग सम्बन्धित देखिन्छ । ईशाको चौथो शताब्दीमा Aristotle (322 BC-384 BC) ले पृथ्वीमा हुने अति ढिलो परिवर्तनको व्याख्या गरेको पाइन्छ । उनको यो व्याख्यामा पृथ्वीमा हुने परिवर्तनहरू एउटा मानिसको जीवनकालमा सजिलै अनुभूति गर्न सकिदैन भनिएको छ । मध्ययुगमा मुश्लिम भू-गर्भविद Biruni (973-1408 AD) ले भारतको भू-गर्भ लेख्ने क्रममा भारतीय महाद्वीप एकपटक समुद्रमा थियो भनेका छन् । सत्रौं शताब्दीपछि क्रमिक रूपमा भू-गर्भ विज्ञानले आफ्नो क्षेत्रमा द्रुतगतिमा फड्को मार्दै गएको देखिन्छ ।

सत्रौं शताब्दी

वास्तवमा सत्रौं शताब्दीसम्म भू-गर्भशास्त्रको विकासको शुरुआत देखिंदैन । भू-गर्भ विज्ञान उक्त कालखण्डसम्म प्राकृतिक विज्ञान (Natural Science) को एउटा एकाइ (entity) का रूपमा मात्र रहेको पाइन्छ । यसै शताब्दीमा क्रिस्चियनहरूको धर्मग्रन्थ बाइबलमा फरक किसिमले पृथ्वीको बारेमा धारणा बनाएको र त्यसको प्रमाण जुटाउने क्रममा पनि भू-गर्भ विज्ञान र भूगोलका सम्बन्धमा अनेक तर्कनाहरू शुरुआत भएको पाइन्छ (Frank, 1938) । क्रिस्चियनहरूको धर्मसँग सम्बन्धित पृथ्वीको इतिहासको वैज्ञानिक खोज गर्ने क्रममा William Whiston ले सन् १६१६ मा A new Theory of the Earth नामक पुस्तक प्रकाशित गरे । उक्त पुस्तकमा ठूला बाढी र चट्टान बन्ने प्रक्रियाको सम्बन्ध व्याख्या पनि गरिएको छ (Gohaum 1990) । सन् १९४९ मा फ्रेन्च नेचुरलिस्ट Georges Louis Leclere ले Historic Naturelle नामक पुस्तक प्रकाशन गरी बाइवलका आधारमा क्रिस्सियनहरूले वर्णन गरेको पृथ्वीको उमेर ४०००-५५०० वर्ष भनिएकोमा ७५,००० वर्ष भन्दा बढी भएको खुलासा गरे (Jardine et al. 1996) । त्यसै समयको आसपास अर्थात् सन् १७५५ मा Immanuel Kant ले आफ्नो पुस्तक Universal Natural History and Theory of Heaven मा पृथ्वीको उत्पत्ति न त कुनै भगवानबाट भएको हो न त बाइबलबाट भन्दै छुट्टै सिद्धान्तको व्याख्या गर्न पुगे । त्यसपछि धार्मिक दृष्टिकोणले भन्दा वैज्ञानिक दृष्टिकोणबाट पृथ्वीको उत्पत्ति तथा यसमा रहेका बहुमूल्य वस्तुहरूको खोजी हुन थाल्यो ।

सर्वप्रथम Geology भन्ने शब्द दुई जना Genevian naturalists: Jean-Andre Deluc र Horace-Benedict de saussure ले professionally प्रयोग गरेको पाइन्छ (Gohaum 1990) । तथापि Geology को जनप्रिय प्रयोग भने सन् १९५१ मा Denis Diderot ले लेखेको the Encyclopedie को प्रकाशन पछि भेटिन्छ । सन् १७४१ मा France को प्रसिद्ध शैषिक संस्था The National Museum of Natural History मा पहिलो पटक Geology लाई Study of Earth and its History का नाममा पढाएको पाइन्छ जुन भू-गर्भ विज्ञानको विकासका लागि कोशेढुङ्गा साबित हुन पुग्यो । अब बिस्तारै जियोलोजी प्राज्ञिक संस्थाका रूपमा देखा पर्दै जान थाल्यो । सन् १७७०मा पृथ्वीमा रहेका चट्टानका सम्बन्धमा दुईवटा मुख्य सिद्धान्तहरू देखा परे । त्यसमध्येका एकजना सिद्धान्तकर्मी जर्मन भू-गर्भविद, Abraham Werner ले पृथ्वीको सतहमा रहेका चट्टानका तहको अध्ययन गरी basalt र granite लाई समुद्रबाट थेग्रिएर (Precipitate) पृथ्वीलाई छोपेको तर्क प्रस्तुत गरे । उनको यो तर्क मान्नेहरू Neptunists मानिन्छन् (Frank, 1938), दोस्रो सिद्धान्त प्रतिपादन गर्ने व्यक्ति Scottish naturalist, James Hutton (1726-1797) थिए जो Neptunist को विरुद्धमा थिए । Hutton ले Theory of Plutonism मा पृथ्वी 'पग्लेको पिण्ड बिस्तारै जमेर' बनेको हो र त्यो प्रक्रिया वर्तमानमा पनि रहेको छ भनि तर्क गरे । उनले पृथ्वीको उमेर धेरै पुरानो रहेको समेत खुलासा गरे । Plutonists का अनुसार मुख्यतयाः ज्वालामुखी प्रक्रियाबाट नै

चट्टानहरू बनेको व्याख्या हुन आयो । Basalt र granite पनि पृथ्वी भित्र पग्लेको वस्तु बाहिर निस्केर बनेका आग्नेय चट्टान हुन भन्ने तर्क दिइयो । यसरी Scotland का फिजिसियन Hutton को रुची विस्तारै Geology तिर पुग्यो । उनी त्यो समयमा plutonists का अगुवा बन्न पुगे । उनको सबैभन्दा सर्वमान्य धारणा The present is the key to the past अर्थात् वर्तमान प्रक्रियाहरू बितेको समयमा पनि थिए भन्ने थियो । यस अवधारणाले वस्तुतः Uniformitarianism लाई आत्मसात गऱ्यो जुन catastrophism को खण्डनमा आयो । Hutton ले आफ्ना भौगर्भिक धारणाहरू समेटेर पुस्तकहरू पनि लेखे तर कम संख्या र बढी मूल्यमा छापिएका उनका पुस्तकहरू जताततै फैलिन नसक्दा उनका विचारहरूको प्रभाव साँघुरो घेरामा रहन पुग्यो ।

अठारौं शताब्दी (18th Century)

उत्तर अमेरिकातिर दृष्टि पुऱ्याउँदा सन् १७९० देखि १८२० लाई the Heroic age of geology भनिएको पाइन्छ (Zittel 1901) । तर अमेरिकन geomorphology मा भने सन् १८७५ देखि सन् १९०० को समयलाई Heroic age भन्न सकिन्छ भनी Thornebury (1997) ले उनको पुस्तक Principles of Geomorphoplogy मा लेखेका छन् । W. M. David (1850-1934) ले geomorphic cycle को अवधारणा ल्याउन सफल भए । Davis को यो धारणा पनि geomorphology मा कोसेढुङ्गा साबित हुन पुग्यो । खनिजको क्षेत्रमा James Dwight Dana (1813-1895) को योगदान ज्यादै उल्लेखनीय छ । त्यसै समयमा अमेरिकाका भू-वैज्ञानिक तथा जीवाश्मविद् James Hall (1811-1898) ले Index Fossils को अवधारणा भित्राए ।

यस शताब्दीको पूर्वार्द्धमा आएर खनिज पदार्थको पहिचान गर्ने र यसको प्रयोगका विषयमा अध्ययन हुन थाल्यो । युरोपमा खनिज उत्खनन् गरी बिक्री वितरण गर्ने कार्यको शुरुआत पनि यसै शताब्दीको प्रारम्भमा हुन पुग्यो (Jardine et al. 1996) । त्यसमा पनि किमती र अर्ध किमती (precious and semi-precious) खनिजको खोजी र उत्खनन् पछि भू-गर्भ विज्ञानले विश्व बजारमा सनसनी ल्याउन पुग्यो ।

अठारौं शताब्दीको मध्यबाट भू-गर्भ विज्ञानलाई विज्ञानको छुट्टै विधाका रूपमा हेरिन थालियो । Hutton को मृत्यु पश्चात उनका साथी John play fair (1748-1819) ले १८०२ मा Illustrations of the Huttonian Theory of the Earth प्रकाशित गरे । गणितका प्राध्यापक फेयरले Hutton को सिद्धान्तहरू यत्रतत्र फैलाउन सके र धेरैलाई प्रभाव पार्न समेत सफल भए । Hutton को प्रभाव बोकेका युरोपका वैज्ञानिक Sir Charles Lyell (1797-1875) ले Uniformitarianism को थप व्याख्या गर्दै थुप्रै पुस्तकहरू लेखे जसमध्ये Principles of Geology (1872) प्रमुख थियो ।

उन्नाइसौं शताब्दी (19th Century)

उन्नाइसौं शताब्दीको शुरुमा पृथ्वीमा रहेका नयाँ र पुराना चट्टानहरूको क्रमिक अध्ययन शुरु हुन थाल्यो । यसै समयमा युरोपमा ice age को प्रमाण पत्ता लगाइयो । भू-गर्भ विज्ञानको क्षेत्रमा विकासवादी वैज्ञानिक Charles Darwin को योगदान पनि उल्लेखनीय छ । Darwin ले सन् १८३१ मा आफ्नो Bachlor's Degree सकेर Adam Sedgwick जसले सन् १८३० मा Cambrian Succession को भौगर्भिक नक्साङ्कन गरिसकेका थिए, सँग दुई हप्ताको Welsh mapping expedition मा गएका थिए जुन बेला उनको Geology मा छ महिनाको spring course पनि सकिएको थियो । त्यसबेला उनको हातमा Lyell को Principles of Geology आइपुग्यो । त्यस पुस्तकको अध्ययन र Darwin को आफ्नो स्थलगत अध्ययनबाट उनले अवशेषहरूको अध्ययनबाट जीवहरूको बारेमा नयाँ तथ्यहरू पत्ता लगाउन सफल भए । सन् १८५९ मा 'Origin of Species' भन्ने पुस्तक प्रकाशित भयो । उनको पुस्तक पढ्नेहरूको घुइँचो लाग्यो । पादरीहरू तर्सिएर बरबराउन लागे । केही विद्रोहीहरू उनको पछि लागे । उनको प्रशंसा गर्नेहरू पनि कम भएनन् । उनलाई प्रशंसा गर्ने र घृणा गर्नेहरूको समूह बन्यो । यसरी चर्को विवादमा मुछिए चार्ल्स डार्विन । उनको अर्को पुस्तक 'Decent of the Man' प्रकाशित भयो । यसले समाजमा ठूलो खैलाबैला मच्चायो । मानिसका पूर्खा एक प्रकार का बाँदर हुन् भन्ने कुरा अगाडि सारेका थिए डार्विनले । सन् १९७० मा William Smith ले इङ्गल्याण्डमा भौगर्भिक नक्साको शुरुआत गरे । उनले अवशेषको सहायताबाट एउटा चट्टानको पत्र लामो फैलावटमा हुने कुरा अवलोकन गरे । त्यसबाट चट्टानहरू ठूला-ठूला depositional basin मा बन्दा रहेछन् भन्ने तर्क अगाडि ल्याए । त्यसै समयमा French Comparative anatomist Georges Cuvier र उनका साथी Alexandre Brogniart ले चट्टानको Original Position र त्यसमा पाइने जिवावशेषको आधारमा जिवावशेषको तुलनात्मक उमेर पत्ता लगाउन सकिने व्याख्या गरे (Albritton 1980) । पछि उनीहरूले Stratigraphy को किताब पनि प्रकाशित गरे । यसको कारण धेरे ठाउँमा stratigraphic column बनाउने र पृथ्वीको उमेर पत्ता लगाउन चट्टानका विभिन्न श्रेणीहरू छुट्टाउने कार्यहरू हुन थाल्यो । उन्नाइसौं शताब्दीको मध्यसम्म stratigraphic column बनाउने कार्य ऋण्डैऋण्डै सकिएको देखिन्छ । त्यसपछि भौगर्भिक पात्रोको कङ्काल बन्न पुग्यो ।

यसै शताब्दीमा धेरै देशहरू जस्तै क्यानडा, अष्ट्रेलिया, ग्रेट ब्रिटेन र अमेरिकाका सरकारले भू-गर्भ विज्ञानको क्षेत्रमा ठूलो लगानी गरी जनशक्ति उत्पादन गर्ने तथा आ-आफ्नो देशमा भौगर्भिक नक्सा (geological map) बनाउने कार्यमा जुटे । जसको कारणले देश विकासका लागि अति आवश्यक खनिजहरू, तेल तथा कोइला पत्ता लाग्न थाल्यो । भू-गर्भमा यसरी क्रमिक रूपमा नयाँ-नयाँ अनुसन्धानहरू हुँदै गए र सोही अनुसारका प्रविधिहरू जन्मिन थाले । उन्नाइसौं शताब्दीको अन्त र २० औं शताब्दीको शुरुसम्ममा भएका प्रयासबाट एकातिर पृथ्वीको उमेर २ बिलियन वर्षको अनुमान गर्न सकियो भने अर्कातिर पृथ्वीमा भएका अनगिन्ती भौगर्भिक सम्पदाहरूको उत्खनन् हुन थाल्यो । खनिज तथा चट्टानको Radiometric dating गरी विभिन्न ठाउँका चट्टानको उमेर भन्न सकिने भयो र भौगर्भिक पात्रोको कङ्कालमा मासु-नसाहरू भरिन थाले । पछिल्ला अनुसन्धानहरूबाट पृथ्वीको आयु ज्यादै पुरानो भएको थाहा लाग्यो (हालमा यसको आयु लगभग ४.५ बिलियन वर्ष भनिएको छ) ।

बीसौं शताब्दी (20th Century)

यस कालखण्डको शुरुमा भु-गर्भ विदहरू महादेश र महासागर बन्ने प्रक्रियाको अध्ययन गर्न तिर लागे । सन् १९१२ मा Alfred Wegener ले एउटा ज्यादै रोचक सिद्धान्त Continental Drift पत्ता लगाए । यो सिद्धान्तअनुसार कुनै समयमा पृथ्वीमा रहेको सबै महादेशहरू एउटै ढिक्का थिए र यसलाई चारैतिरबाट पानीले घेरेको थियो, त्यो एउटा मात्र जमिनको पिण्डलाई Pangaea भनियो । समय बित्दै जाँदा पृथ्वीको Mantle मा उत्पन्न भौगोर्भिक हलचलले सिङ्गो पिण्ड टुक्रिएर अहिलेको

बिभिन्न पिण्डहरूमा छुट्टिएको खुलासा भयो । तर पनि उनको यो तर्क सन् १९६० अर्थात् उनी बाँचुन्जेल स्वीकार हुनु सकेन । सन् १९६० मा नयाँ प्रमाणका साथ उनको उक्त सिद्धान्तले मान्यता पाउन सफल भयो । उनको उक्त सिद्धान्तलाई त्यसपछि plate tectonics बाट व्याख्या गरिन थाल्यो । यस्तो नयाँ प्रमाण जुटाउने वैज्ञानिकहरूमा अमेरिकन Oceanographers Bruce Heezen र Maurice Ewing थिए । सन् १९५० मा उनीहरूले Mid-oceanic ridge को बारेमा व्याख्या गर्न सके । पछि आएर सन् १९६० मा Princeton University का Harry Hess ले sea-floor spreading अर्थात समुद्रको भुँइ कसरी फैलिएको छ भनी वैज्ञानिक तवरले व्याख्या गरे। त्यसपछिको एक दशक सारा भूगर्भविद् र भौतिकविद्हरू महादेश र महासागर बन्ने प्रक्रियाको नयाँ सिद्धान्त Sea-floor spreading को अध्ययनमा जुटे । यसै क्रममा palaeomagnetism को अध्ययन अगाडि बढ्यो र यस आधारमा समुद्रको पिँधमा बनेका चट्टानहरू महादेशमा रहेका चट्टानहरूभन्दा नयाँ प्रमाणित हुन पुगे अर्थात एउटा महादेश छुट्टिएर दुईवटा बन्ने प्रक्रियामा बीचमा समुद्र बन्ने र सो प्रक्रियामा निस्केका ज्वालामुखीबाट निस्केको तरल (Lava) समुद्रको पिँधमा नयाँ चट्टान (basalt) बन्ने व्याख्या गरियो भने समुद्रको मध्य भागमा लामो दूरीसम्म फैलिएका डाँडाहरू रहेको प्रमाणित हुन पुग्यो । महादेशहरू छुट्टिने मात्र नभई एक आपसमा ठोक्किने र पहाडहरू बन्ने प्रक्रिया पनि Plate tectonics अन्तर्गत नै व्याख्या हुन पुग्यो । यसै सिद्धान्तको आधारमा नै टेथिस नामको पुरानो महासागरको अन्त्य भै इन्डियन र तिबेतियन महादेशको जुदाइबाट हाम्रो हिमालको उत्पत्ति भएको व्याख्या हुँदै आएको छ । Plate tectonics को सिद्धान्तको प्रतिपादन भएपछि भू-गर्भ विज्ञानमा नयाँ युगको सुरु हुन पुग्यो । त्यो भन्दा अगाडिका सारा अध्ययनलाई यसै सिद्धान्तसँग जोडेर अध्ययन गर्न थालियो । Magmatism, metamorphism, seismicity देखि लिएर खनिज सम्पदाको खोज अनुसन्धानमा समेत यो सिद्धान्तले नयाँ बाटो कोरिदियो ।

वर्तमान समय (Modern times)

जनसंख्याको अत्यधिक वृद्धि र सोही अनुपातमा भएको औद्योगिक विकासले गर्दा एकातिर भौगर्भिक सम्पदाहरू जस्तै : खनिज, तेल, ग्यास तथा कोइलाहरू सकिँदै गएको छ भने अर्कातर्फ यस्ता सम्पदाहरूको अत्याधिक उत्खनन् र प्रयोगले विश्वको प्राकृतिक वातावरणमा प्रतिकुल असर देखिएको छ । यस अवस्थामा भू-गर्भविदहरूको अध्ययन क्षेत्र पनि प्रष्ट रूपमा दुई भागमा बाँडिएको छ । एकातर्फ नयाँनयाँ प्रविधिहरूको प्रयोग गरी हामीलाई चाहिने जति खनिजहरू खोज्नु परेको छ भने अर्कातर्फ अत्याधिक उत्खनन्बाट देखिएका समस्याहरू पनि हल गर्नु परेको छ । खनिज तथा पानीको अत्यधिक उत्खनन् र जसको असरले गर्दा निम्तिएका प्राकृतिक प्रकोपहरू, रोगहरू र वातावरणीय प्रभावको न्यूनीकरणमा भू-गर्भविद्हरूले सोच्नु पर्ने भएको छ । अहिले बढि नै चर्चामा रहेको Global Warming तथा Climate Change सँग सम्बन्धित भौगर्भिक कारणहरू पत्ता लगाउनु पर्ने भएको छ । Global Warming ले निम्त्याएका असरहरू मध्ये अग्ला पहाडका टुप्पामा रहेको हिउँ पग्लने दर बढ्न जाँदा त्यसले बाढी, पहीरो तथा वनजगल विनासको समस्या ल्याएको छ भने समुदमा पानीको सतह बढ्न गै यसका आसपासका क्षेत्रहरू डुबानमा परेका छन् । भू-कम्प तथा ज्वालामुखी विस्फोटनको वैज्ञानिक रूपमा भविष्यवाणी गर्न नसकिँदा वर्षेनी लाखौं मानिसको मृत्यु हुने गरेको छ । पानीमा मिसिएका heavy minerals को विषालुपनाले नयाँ पुस्ताको मानसिक तथा शारीरिक विकासमा समेत असर पुऱ्याउन सक्ने वैज्ञानिक अनुमान गरिएको छ । भूमिगत जलको अत्याधिक प्रयोगले जमिन भासिने तथा समुद्रको नुनीलो पानी जमिन तर्फ बग्ने प्रक्रियाहरू पनि समस्याका रूपमा देखिएका छन् । पहाडी क्षेत्रमा भू-क्षय र पहीरोले मानिसले सृजना गरेका बाटो, पुल, पुलेसा, विद्युत् तथा बस्तीलाई दिन-दाहाडै चुनौती दिएको छ । तेलका कैयौं खानीहरू रित्तिएका छन्। न्युम्लियर इनर्जीको अध्यधिक प्रयोग पछि Radioactive Wastage लाई सुरक्षित रूपमा व्यवस्थित गर्न अरबौं धनराशी खर्च गर्दा पनि यसको जोखिम निराकरण हुन सकेको छैन । शहरबाट निस्कासित फोहोरले पानी, माटो र हावा दुषित भै सिङ्गो वातावरण नै आक्रान्त छ । मानिस शहर छोडेर गाउँको प्राकृतिक वातावरणतर्फ फर्किन चाहेको छ । हिजोको समयमा भौगर्भिक सम्पदाहरूको अभावले मानिस जङ्गली युगमा थियो । आज यस्ता सम्पदाहरूको प्राप्तीले मानिस चाहिने भन्दा बढी सुविधाभोगी बनेको छ । तर यी सम्पदाहरू पृथ्वीमा सिमित छन् । यीनको प्राप्तीमा कमी हुनासाथ मानिस कुन विकल्पमा जाने वा कसरी नयाँ सम्भावित ठाउँ पत्ता लगाउने भन्ने चुनौतीको सामना गर्नु पर्ने भएको छ । त्यसैले भू-गर्भविद्हरूले छिट्टै माथि उल्लेख गरीएका समस्याहरूको छिटो र भरपर्दो समाधान (sustainable solution) खोज्नु पर्ने भएको छ । जमिनबाट रित्तिदै गएका सम्पदाको विकल्पमा समुद्रलाई प्रयोग गर्नु पर्ने भएको छ । अर्का तर्फ मानिस सभ्यताको शुरुमै तेर्सिएको पृथ्वीको उत्पत्ति कसरी भयो अर्थात् शुरुमा पदार्थ कसरी बन्यो जस्ता कैयन प्रश्नहरू आज पनि अनुत्तरीत छन् । यसको राम्रो छिनोफानो हुन सकेमा पृथ्वीमा रहेका सम्पदाको विकल्प ब्राहमण्डका अन्य पिण्डहरू पनि हुन सक्ने थिए कि ! यिनै प्रश्नहरू वा समस्याहरू सँग सम्बन्धित अनुसन्धान र समाधान नै आजको भू-गर्भ विज्ञानको क्षेत्रमा सोंच र दर्शन हो ।

निष्कर्ष

मानव विकासका लागि अपरिहार्य विज्ञानका बिभिन्न विधाहरूमध्ये भू-गर्भ विज्ञानको महत्व अग्रस्थानमा छ । यो विज्ञानले आधुनिक युगमा आइपुग्नु अगाडि लामो यात्रा गरिसकेको छ । यस यात्रामा थुप्रै पूर्वीय तथा पाश्चात्य दर्शनहरूको प्रभाव परेको देखिन्छ । पूर्वीय दर्शन अर्न्तगत वेद, उपनिषद्, पुराण, गीतादेखि लिएर स्वस्थानी, रामायण र महाभारतसम्मका हिन्दू धर्म ग्रन्थहरूमा पृथ्वीको उत्पत्ति तथा यसको ब्रह्माण्डमा रहेको सम्बन्ध विभिन्न कोणहरूबाट उल्लेख गरिएको छ । पूर्वीय दर्शनभित्रको अवतारवाद आफैमा एउटा अनौठो चिन्तन हो । यसले प्राणीको विकासवादलाई समातेको छ । पृथ्वी लगायत हाम्रो ब्रह्माण्डका हरेक पिण्डहरू नाशवान छन् भन्दै आजको मानव सभ्यताको अन्तहुने खुलासा गरेको छ, जुन कुरा आज भूगर्भ, भौतिक तथा खगोल विज्ञानले समेत स्वीकार गरी सकेको छ । यसले के देखाउँछ भने यस्ता थुप्रै तथ्यपरक आध्यामिक चिन्तनबाट वैज्ञानिक चिन्तनमा रूपान्तरण हुन हाम्रा अग्रज भू-गर्भ वेत्ताहरूलाई पक्कै प्रेरणा मिलेको थियो । अर्कातिर पश्चिमी दर्शन ईश्वरीय लीलामा भन्दा मानव जातिको इहलीलाको खोजमा नै बढी रमाएको छ । यस सभ्यतामा पनि बाइबलको अध्यात्मिक चिन्तन नभएको त होइन, हुँदा-हुँदै पनि धेरै दर्शनहरू वैज्ञानिक तथ्यको नजिक हुन पुगे जसको फलस्वरूप भू-गर्भ विज्ञानमा पाश्चात्य दर्शनको प्रभाव बढी नै देखिन्छ । विभिन्न कालखण्डमा विशेष किसिमका अवधारणका साथ भू-गर्भ विज्ञान पटकपटक उचाइमा पुग्दै आजको पृष्ठभूमिमा आईपुगेको छ ।

यस क्रममा Scottosh Naturalist, James Hutton (1726-1797 A. D.) ले Neptunist को विरुद्धमा पृथ्वी पग्लेको पिण्ड बिस्तारै जमेर बनेको भन्दै सर्वमान्य धारणा The present is the key to the past को व्याख्या गरे । त्यो समयमा उनी plutonist का अगुवा भए र उनको यस सिद्धान्तलाई आत्मसाथ गर्दै Playfair ले उनको मृत्युपछि उक्त सिद्धान्तलाई व्याख्या गर्दै पुस्तक लेखे भने Charles Lyell ले Theory of Uniformitarianism व्याख्या गरे । विकासवादी वैज्ञानिक Charles Darwin ले सन् १८५९ मा Origin of Species मा प्राणीहरूको विकासक्रम व्याख्या गरे जसका लागि उनको अवशेषहरूको अध्ययन भू-गर्भ विज्ञानमा कोशेढुङ्गा साबित भयो । त्यसैगरी सन् १९७० मा William Smith ले इङ्गल्याण्डमा भौगर्भिक नक्साको शुरु गरी चट्टान तथा जीवावशेषको सम्बन्ध स्थापित गरे । सन् १९१२ मा Alfred Wegener ले Continental Drift को सिद्धान्त, सन् १९६० मा Harry Hess ले Sea Floor Spreading को सिद्धान्त प्रतिपादन गरे पछि भौगर्भिक विज्ञान नयाँ उचाइमा पुग्यो । नयाँ कोणबाट खनिज, तेल, ग्यास तथा कोइला खोजिन थाल्यो र औधोगिक युगले सफलता प्राप्त गऱ्यो । आध्यामिक चिन्तनको गहिरो प्रभावबाट आजको यो अवस्थासम्म आइपुग्न धेरै वैज्ञानिकहरूको ठूलो सङ्घर्ष र धैर्य धारण देखिन्छ । यस उदाहरणको लागि James Hutton को जीवनकालमा उनको सिद्धान्त जनप्रिय बन्न सकेन र डार्विनले मानिसका पूर्खा एक प्रकारका बाँदर हुन भन्ने कुरा अगाडि सार्दा धेरै व्यक्ति उनको कुरामा सहमत भएनन । उल्टै डार्विनको अनुहारलाई बाँदरको जस्तोबनाएर डार्विनको पूर्खा भनि गिल्ला गर्न पुगे । सन् १९१२ मा Albred Wegner ले व्याख्या गरेको Continental Drift को सिद्धान्तले सन् १९६० अर्थात उनी बाँचुन्जेल मान्यता पाउन सकेन । यस्ता थुप्रै चुनौतीका बीचबाट पनि भू-गर्भशास्त्र आजको उचाइमा आइपुग्यो । वर्तमानमा भने यस विज्ञान छुट्टै समस्या लिएर उभिएको छ । एकातिर संसारबाट खनिज पदार्थहरू सकिँदै गएको अवस्थामा नयाँ वैकल्पिक उपायहरू खोज्नु ज्यादै चुनौतीपूर्ण बनेको छ भने अर्कातर्फ खनिजको अत्यधिक उत्खनन्ले प्राकृतिक वातावरणमा गम्भिर समस्याहरू उत्पन्न भएका छन् । कुनै समयमा भौगर्भिक सम्पदा प्रयोग गर्ने ज्ञानको अभावले मानिस जङ्गली युगमा थियो आज पुनः कतै प्राकृतिक वातावरणको खोजीमा मानिस उद्योग धन्दा बन्द गरी त्यही युगमा फर्किन पर्ने त होइन भनि चिन्ता बढेको छ । प्राकृतिक प्रकोपहरूका विरुद्ध मानिसले आज पनि उत्तिकै सङ्घर्ष गरिरहेको छ । भू-कम्प, ज्वालामुखी, बाढी-पहीरो जस्ता प्रकोपको समयमै भवियवाणी गर्न सकिएको छैन । यस्ता थुप्रै समस्याहरूलाई सम्बोधन गर्न सक्ने दीर्घजीवि सोच र दर्शनका साथ अगाडि बढ्नु पर्ने अभिभारा आजका भू-गर्भविद् माथि आइपरेको छ ।

आभार

यस आलेख तयार गर्ने क्रममा गरिएका प्राज्ञिक विमर्शका लागि त्रि. वि. भूगर्भशास्त्र केन्द्रीय विभागका सहप्राध्यापक एवं वरिष्ठ साहित्यकार डा. खुमनारायण पौडेलप्रति आभार व्यक्त गर्दछु ।

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वनस्पतिका फल र वीजका जीवावशेष : प्रागजलवायु अध्ययनका सशक्त माध्यम

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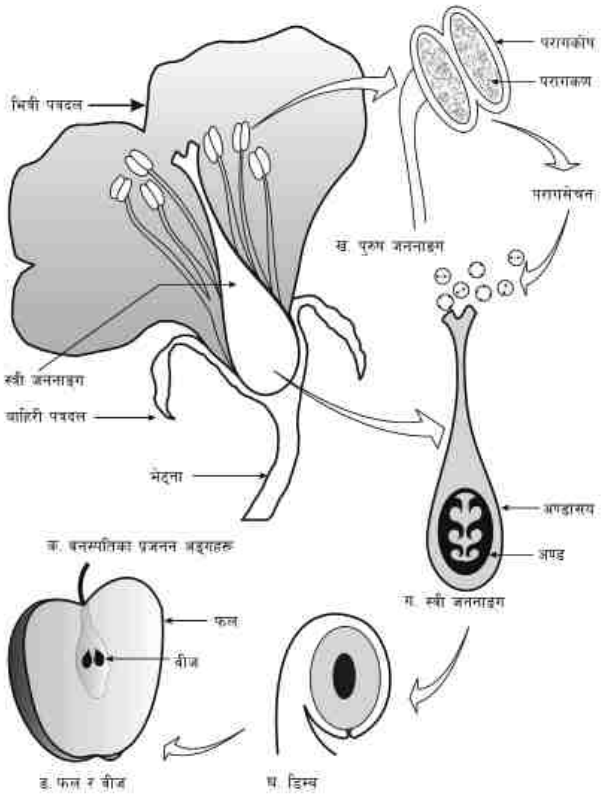
सारांस

प्रागजलवायु (palaeoclimate) अध्ययन अनुसन्धानका लागि वनस्पतिका म्याक्रोफोसिल (फल, फलका विभिन्न अङ्ग र वीज) को अध्ययन अत्यन्त महत्वपूर्ण मानिन्छ । फल र वीजहरू गह्रौं हुने भएकाले स्रोत वनस्पतिबाट धेरै टाढासम्म पुग्न सक्दैनन् । त्यसैले स्थानीक (local) प्रागवातावरण अध्ययनका लागि पात, फल र वीजका जीवावशेषहरू प्रभावकारी माध्यम (proxy) बन्न सक्दछन् । नेपालको काठमाडौँ उपत्यकामा नरम चट्टानहरूमा रहेका म्याक्रोफोसिलको माध्यमबाट जलवायु परिवर्तनसम्बन्धी केही शोधहरू भइरहेको भए पनि यससम्बन्धी अध्ययनले अपेक्षित गति लिन सकेको देखिदैन । यस लेखमा वनस्पतिका म्याक्रोफोसिल अध्ययनको क्षेत्र, विधि, उपयोगिता र महत्वका बारेमा जानकारी दिने प्रयास गरिएको छ ।

परिचय

फल पुष्पक वनस्पतिहरूको वंश निरन्तरताको माध्यम हो । एउटा फल भित्र एक वा एकभन्दा धेरै सङ्ख्यामा बीजहरू रहेका हुन्छन् । माटोको संसर्ग पाएपछि वीजहरू उम्रिन्छन् अनि बढ्दै गएर वयस्क बिरुवा बन्छन् । कुनै पनि वनस्पतिमा फल सिर्जना हुनका लागि स्त्री र पुरुष पुष्पको उपस्थिति अनिवार्य छ । पुष्पक वनस्पतिहरूले फूलमा रहेको पुरुष जननाङ्ग (androecium) को टुप्पामा अवस्थित परागकोषमा (anther) परागहरू (pollen) उत्पादन गर्दछन् । त्यस्तै फूलमा रहेका स्त्री जननाङ्गले (gynoecium) अण्ड (ovum) उत्पादन गर्दछन् । स्त्री जननाङ्ग (gynoecium) को सङ्ख्या फूलको प्रजाति अनुरूप एक वा एकभन्दा बढी सङ्ख्यामा उपलब्ध हुन सक्दछ । कुनै वनस्पतिमा पुरुष र स्त्री जननाङ्गहरू एउटै फूलमा रहेका हुन्छन् । यस्ता वनस्पतिलाई डायोसियस (dioceous) वनस्पति भनिन्छ । कुनै वनस्पतिमा पुरुष र स्त्री जननाङ्ग भएका फूलहरू फरकफरक हुन्छन् । यस्ता वनस्पतिलाई मोनोसियस (monoceous) वनस्पति भनिन्छ । साधारणतयाः परागकणलाई पुष्पवीर्य भन्न सकिन्छ । परागकणको मुख्य कर्म परागसेचन अर्थात गर्भाधान हो । परागसेचनका लागि परागहरू स्त्रीपुष्पको जननाङ्ग (gynoecium) सम्म पुग्न आवश्यक छ । सन्तानोत्पादनका लागि वनस्पतिलाई मानव वा अन्य जीवजन्तुको जस्तो सुविधा छैन । वनस्पतिहरू हिँडेर सम्भोगका लागि आफ्नो इच्छित जोडीसमक्ष पुग्न नसक्ने हुँदा उनीहरूले विशेष रणनीति बनाएका छन् । हावा, पानी, कीराफट्याङ्ग्रा, चराचुरुङ्गी अथवा अन्य प्राणीहरूका माध्यमबाट परागकणहरू स्त्रीपुष्पको संसर्गमा पुग्छन् र परागसेचन कार्य सम्पन्न हुन्छ । हावा, पानी र प्राणीद्वारा परागसेचन हुने वनस्पतिहरूलाई क्रमस एनेमोफिलस (anemophilous), हाइड्रोफिलस (hydrophilous), जुफिलस (zoophilous) वर्गमा विभाजन गरिएको छ । परागसेचन पश्चात स्त्रीपुष्पको जननाङ्गमा अवस्थित डिम्ब (Ovum) को न्युक्लियससँग परागकणको न्युक्लियसको मिलन हुन्छ । यस प्रक्रियालाई गर्भाधान (fertilization) भनिन्छ । गर्भाधानपछि युग्मज क्रमशः डिम्ब अनि फलका रूपमा बृद्धि हुन थाल्दछ । फलबृद्धिकै क्रममा फलभित्र वीजको समेत विकास हुने प्रक्रिया शुरु हुन्छ (चित्र नं. १) ।



चित्र नं. १. सन्तानोत्पादनमा प्रत्यक्ष संलग्न फूलका अङ्गहरू ।

म्याक्रोफोसिल अध्ययनको आधारभूत सिद्धान्त

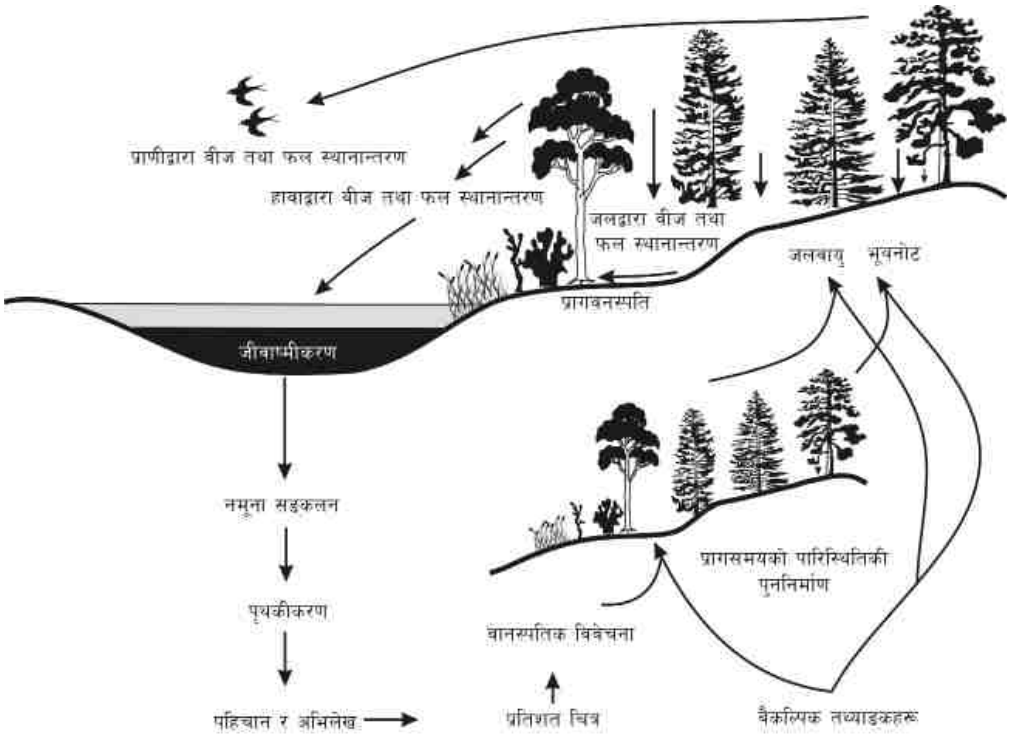
जङ्गलमा विभिन्न जाति एवं प्रजातिका वनस्पतिहरूले उत्पादन गरेका फलहरू परिपक्व भएपछि भूईंमा खस्छन् र कुहिने क्रम शुरु हुन्छ । बाहिरी आवरण (pericarp) कडा भएका फलहरूको कुहिने क्रम

ढिलो हुन्छ भने बाहिरी आवरण नरम भएका फलहरूको कुहिने क्रम छिटो हुन्छ । यस्ता फल र फलबाट निश्रृत बीजहरू (seeds) विभिन्न माध्यमले नदी, ताल वा पोखरी आदिमा पुग्छन् र त्यहाँ थेग्रिएका माटो–बालुवाका अवयवहरूमा (sediments) तिनीहरूको जीवाश्मीकरण (fossilization) प्रक्रिया शुरु हुन्छ । फल परिपक्व भएपछि गुरुत्वका कारण भुइँमा खस्ने प्रक्रियालाई ग्राभिटि डिस्पर्सल (gravity dispersal) भनिन्छ । यस्ता फलहरू माउ वनस्पतिको नजिकै खस्छन् । हावाका माध्यमबाट स्थानान्तरण हुने प्रक्रियालाई एनेमोकोरी (anemochory) भनिन्छ । कुनै फल सुकेपछि आफै विस्फोट हुन्छन् र बीजहरू छरिन थाल्दछन् । यसप्रकारको स्थानान्तरण प्रक्रियालाई ब्यालिस्टिक अथवा अटोकोरी (ballistic or autochory) भनिन्छ । प्राणी वा पानीका माध्यमले पनि बीजहरू एक स्थानबाट अर्को स्थानसम्म पुग्छन् । यसप्रकार को स्थानान्तरणलाई क्रमशः जुकोरी (zoochory) र हाइड्रोकोरी (hydrochory) भनिन्छ । फल वा बीजका आफ्ना मौलिक गुणका आधारमा स्थानान्तरण हुने प्रक्रिया निर्धारण हुने हँदा कुनै फल वा बीज माउ वनस्पतिको नजिकै थुप्रिन्छन् भने कुनै टाढाटाढासम्म पुग्न सक्दछन् । गुरुत्व र ब्यालिस्टिक प्रक्रियाबाट बीज र फलहरू प्रायः माउ वनस्पतिको वरपर छरिन्छन् । प्राणीहरू जस्तै गाईगोरु, भेडाबाख्राको शरीरमा टाँसिएर अथवा चराहरूका माध्यमबाट फल तथा बीजहरू माउ वनस्पतिबाट केही किलोमिटर परसम्म स्थानान्तरण हुन सक्छन् । त्यस्तै हावा वा पानीका माध्यमबाट पनि फल तथा बीजहरू माउ वनस्पतिबाट केही किलोमिटर परसम्म स्थानान्तरण हुन सक्छन् (चित्र नं. २) ।

उपयुक्त अवस्थामा सिङ्गै फल, फलका विभिन्न अङ्गहरू, अनि बीजहरू जीवाश्मीकरण हुने सम्भावना रहन्छ । फल र बीजका जीवावशेषहरूलाई प्लान्ट म्याक्रोफोसिल (plant macrofossil) भनिन्छ । प्लान्ट म्याक्रोफोसिल अध्ययन गर्न सूक्ष्मदर्शक यन्त्रको (microscope) आवश्यकता पर्दछ । भूगर्भविज्ञानमा म्याक्रोफोसिलको अध्ययन प्राणी र वनस्पतिका अन्य जीवाश्मजस्तै चट्टानहरूको अन्तरसम्बन्ध (correlation) र आयु पत्ता लगाउन गरिन्छ । यसका अतिरिक्त पृथ्वीमा विगतमा भएका जलवायु परिवर्तनको अनुसन्धान गर्न प्लान्ट म्याक्रोफोसिलको अध्ययन अत्यन्त उपयोगी साधन भएको छ । वनस्पतिहरू पारिस्थितिकी (ecology) प्रति अत्यन्त संवेदनशील हुन्छन् । परिस्थिति प्रणाली (ecosystem) मा हुने ससानो परिवर्तनले पनि वनस्पतिको विविधता, विस्तार, विकासमा ठूलो असर पार्दछ । प्लान्ट म्याक्रोफोसिलको मद्दतले प्रागभूगोल (paleogeography), प्रागवनस्पति (paleovegetation), प्रागपारिस्थितिकी (paleoecology) र प्रागवातावरण (palaeoenvironment) को विकास, विविधता र विस्तार पत्ता लगाउन सकिन्छ ।

पृष्ठभूमि एवं नेपाली सन्दर्भ

सन् १९१३ मा स्विडेनका भूगर्भशास्त्री लेन्नार्ट भोन पोस्टले भौगर्भिक निक्षेपहरूबाट परागकणको अध्ययन र विश्लेषण गर्ने आङ्किक पद्धतिको आविष्कार गरेका थिए । यसै कालबाट टर्सिएरी (Tertiary) र क्वाटर्नरी (Quaternary) समयको प्रागवातावरण अध्ययनका क्रममा परागकण सँगसँगै फल र बीजका जीवावशेषको पनि अध्ययन गरिनु पर्ने धारणा विकसित हुँदै गयो । परागकणहरू हावाको माध्यमबाट स्रोत वनस्पतिबाट टाढाटाढासम्म पुग्न सक्ने हुँदा परागकणबाट प्राप्त प्रागवातारणसम्बन्धी जानकारी ज्यादै फराकिलो हुन्छ । त्यसैले क्षेत्रीय (regional) प्रागवातावरण अध्ययनका लागि पूरापरागको अध्ययन प्रभावकारी मानिन्छ । तर फल र बीजहरू गहौं हुने भएकाले स्रोत वनस्पतिबाट टाढाटाढासम्म पुग्न सक्दैनन् त्यसैले स्थानीक (local)



चित्र नं. २. म्याक्रोफोसिल अध्ययनको आधारभूत सिद्धान्त

प्रागवातावरण अध्ययनका लागि पात, फल र वीजका जीवावशेषहरू प्रभावकारी मानिन्छन् (Kienast et al., 2001; Birks, 1973, 2001, 2003)। उन्नाइसौँ र बीसौ शताब्दीमा परागकण सँगै फल र वीजका जीवावशेषको अध्ययनले यूरोप, अमेरिका र जापानका साथै विश्वका विभिन्न देशहरूमा निकै तीव्रता प्राप्त गर्‌यो (Reid and Chandler 1933; Wasylikowa 1967; 1986; Ferguson 1971; Birks 1973; 2001; Van der Burgh 1978; 1983; 1987; 1998; Watts 1978; Friis 1985; Birks and Birks 1980; Manchester 1994; Momohara 1994; Meller 1998; Meller et al. 1999; Mai 2001; Zao et al. 2004; Martinetto 2009)। विश्वका विकसित देशहरूमा वीज र फलका जीवावशेष एवं पुरापरागका आधारमा प्रागवातावरण अनुसन्धानमा व्यापक प्रयोगहरू भइरहँदा नेपालमा भूगर्भशास्त्रीहरू त्यस विषयमा प्रायः अनभिज्ञ नै थिए । सन् २००१ मा ओएनपि लेबोरेटोरी, नेयागावा, ओसाका, जापानका वैज्ञानिक नोबुओ ओइ (Nobuo Ooi) ले काठमाडौँ सिनामङ्ल क्षेत्रमा थिमी फर्मेसनका भौगर्भिक निक्षेपबाट केही वनस्पतिका फल र वीजका जीवावशेष पत्ता लगाएका थिए (Ooi 2001)। हाल फल र वीजका जीवाशेषका आधारमा काठमाडौँ उपत्यकाको प्रागवातावरण परिवर्तनका केही तथ्यहरू त्रिभुवन विश्वविद्यालय, भूगर्भशास्त्र केन्द्रीय विभाग, कीर्तिपुर र चिबा विश्वविद्यालय, जापानका वैज्ञानिकहरूले प्रकाशित गरेका छन् (Bhandari et al. 2009; 2010; 2011a; 2011b) । पात, वीज र फलका जीवावशेष एवं पुरापरागका आधारमा प्रागवातावरण अनुसन्धानको क्रम जारी छ ।

अध्ययन प्रक्रिया

नमूना सङ्कलन

फल तथा वीजका जीवावशेषहरू प्रायः मसिना कणहरू (fine grained) बाट बनेका कार्बनिक पदार्थयुक्त चट्टानहरू जस्तै मडस्टोन (mudstone), सिल्टस्टोन (siltstone), सिल्टिस्यान्ड (silty sand) वा फाइन स्यान्डमा (fine sand) आदिमा पाइन्छन् । नमूना (sample) सङ्कलन गर्दा चट्टानको प्रकार र रङ्गले विशेष महत्व राख्दछ । साधारणतया कार्बनिक पदार्थयुक्त कालो, खरानी वा हल्का खैरो रङ्गका चट्टानका तह (bed) बाट स्याम्पल सङ्कलन गर्ने गरिन्छ । खस्रो (coarse grained), ज्यादै रातो, गाढा खैरो वा हरियो रङ्गका चट्टानहरूमा अक्सिडेसनका कारणले जीवावशेषहरू नष्ट भइसकेका हुन्छन् । प्रायः फल र वीजका जीवावशेषहरू नाङ्गो आँखाले पनि देख्न सकिन्छ । यदि नाङ्गो आँखाले देख्न नसकिने स्थितिमा लेन्स (eye glass) को प्रयोग गरेर स्याम्पल सङ्कलन गर्न सम्भावित तहहरूको छनोट गरिन्छ । प्रत्येक तहबाट (layer) ५ देखि १० किलोग्रामसम्म स्याम्पल सङ्कलन गर्नु पर्दछ ।

पृथकीकरण

प्रयोगशालामा स्याम्पल भित्र्याएपछि पृथकीकरण कार्य प्रारम्भ हुन्छ । यदि स्याम्पल सङ्कलन गर्ने स्थलमा पानीको सुविधा छ भने पृथकीकरण कार्य फिल्डमा पनि गर्न सकिन्छ । तर त्यसका लागि आवश्यक पर्ने जाली (sieve) लगायतका अन्य सामानहरू फिल्डमा उपलब्ध हुनु जरुरी छ । म्याक्रोफोसिल पृथकीकरण कार्य निम्नानुसार गर्न सकिन्छ ।

क. स्याम्पल धुलो रूपमा छ भने त्यसलाई पानीमा डुबाउने र ३–४ घण्टासम्म भिज्न दिने । यदि कडा चट्टानका रूपमा छ भने त्यसलाई हल्का रूपमा घनले कुटेर धुलो पार्ने अनि पानीमा भिजाउने । यस्तो स्याम्पल पग्लिन धेरै समय लाग्न सक्दछ । भिजाएर राख्ने प्रक्रिया पनि लामो हुन सक्दछ ।

ख. भिजिसकेको स्याम्पललाई ०.५ मि. मि. को जाली (sieve) मा छान्ने र अनावश्यक अकार्बनिक पदार्थ हटाउने । छान्दा पानीको फोहोरा प्रयोग गर्नु प्रभावकारी हुन्छ । ठूला साइजका बालुवा, रोडा, गिट्टी (coarse sand and pebbles) हरू हातले नै हटाउन सकिन्छ ।

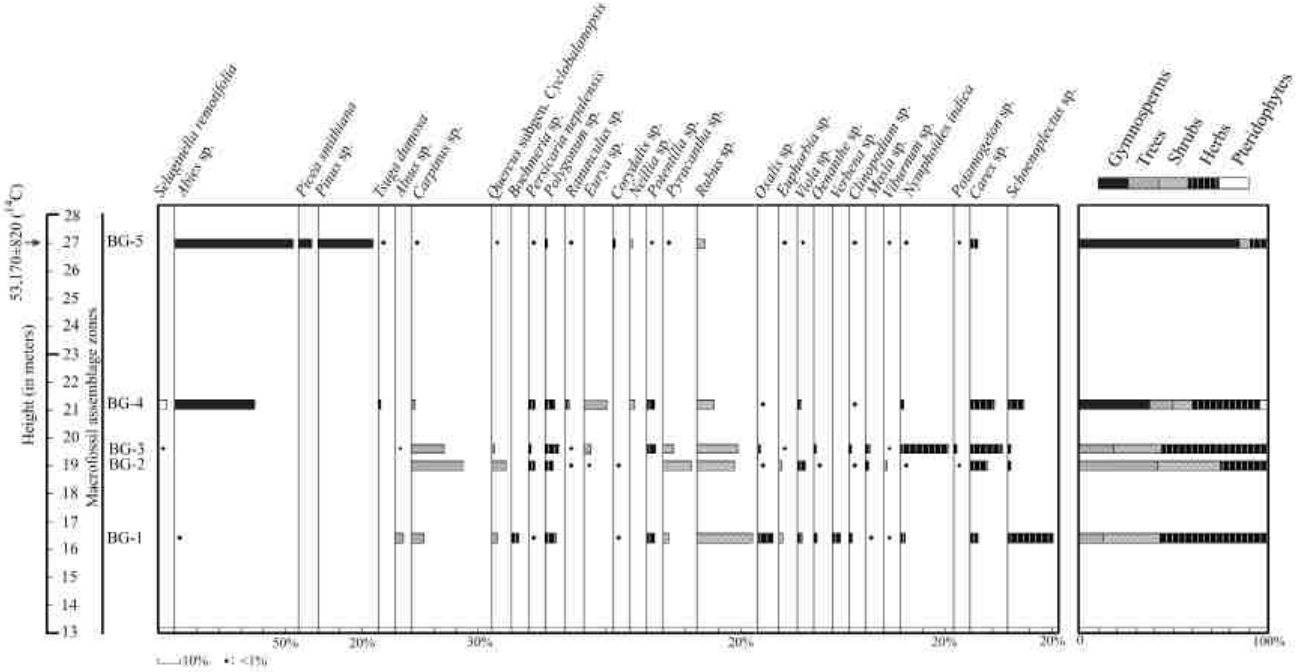
ग. ०.५ मि. मि. को जालीमा रहेको स्याम्पललाई पुनः ४ मि. मि., २ मि. मि., १ मि. मि. ०.५ मि. मि. साइजका जालीहरूमा (sieving) छानिन्छ । प्रत्येक जालीमा बाँकी रहेको स्याम्पल लाई पानीको फोहोराले धोइन्छ र सुकाइन्छ ।

घ. सुकिसकेको स्याम्पललाई वाच ग्लास (watch glass) मा राखिन्छ र स्टेरियोस्कोपिक माइक्रोस्कोपमा अध्ययन गरिन्छ । स्याम्पलमा रहेका वीज र फलका जीवावशेषहरू लाई चिम्टी (forceps), ब्रस (brush) वा निडलका (needle) सहायताले टिपिन्छ र बोतल (sample vials) मा सङ्कलन गरिन्छ ।

पहिचान र अभिलेख

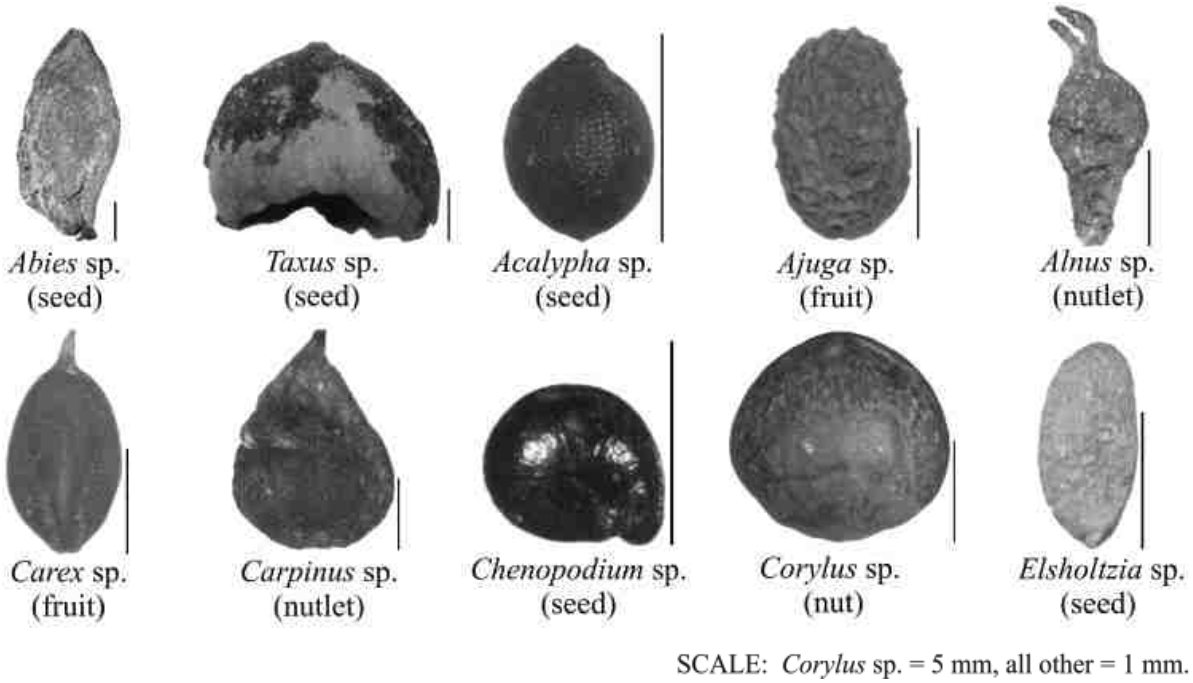
म्याक्रोफोसिल पहिचानका लागि वानस्पतिक ज्ञानको आवश्यकता पर्दछ। सर्वप्रथम म्याक्रोफोसिल कुनकुन वनस्पतिका हुन पहिचान गर्नु नै म्याक्रोफोसिल अध्ययनको पहिलो पाइलो हो । म्याक्रोफोसिलको रङ्ग, बनोट, आकार र सतहमा रहेका विभिन्न आकृति (ornamentation) का आधारमा पहिचान गर्न सकिन्छ । कुनैकुनै म्याक्रोफोसिलहरूको बनोट विशिष्ट प्रकारको हुन्छ । फल वा वीजहरूमा रहेका विशेष बनोटहरू जस्तै पखेटा (wing), रौँ (hair), काँढा (spine) आदिले पहिचानमा सहयोग गर्दछन् । हर्वेरियमबाट बनाइएका सन्दर्भ सामग्री (reference slides) सँग तुलनात्मक अध्ययन गरेर पनि पहिचान गर्न सकिन्छ । यसबाहेक पूर्वप्रकाशित एटलस तथा अनुसन्धनात्मक लेखहरूमा प्रकाशित फोटोसँग तुलना गरेर पनि पहिचान गर्ने चलन छ ।

पहिचानका क्रममा प्रत्येक स्याम्पलमा रहेका सबै फल र वीजहरूको सङ्ख्या गणना गरिन्छ । यसरी गरिसकेपछि कुल सङ्ख्याका आधारमा प्रत्येक जाति वा प्रजातिको प्रतिशत छुट्याउने काम गरिन्छ । यसपछि उक्त तथ्याङ्कको आधारमा एउटा ग्राफ बनाइन्छ जसलाई म्याक्रोफोसिल डायग्राम (macrofossil diagram) भनिन्छ। उपलब्ध म्याक्रोफोसिलहरू कस्तो वृक्ष (tree), पोथ्रा (shrub) अथवा घाँस (grass) वर्गका हुन र तिनले कस्तो पारिस्थितिकी (ecology) मन पराउँछन् त्यस कुराले विशिष्ट अर्थ राख्दछ । फल र वृक्षका जीवावशेषका आधारमा तत्कालीन समयको वनजङ्गलका साथै वनस्पतिको विन्यास ज्ञान हुन्छ अनि प्रागसमयको पारिस्थितिकी पुननिर्माण (palaeoclimate reconstruction) गर्न सकिन्छ । यही प्रतिशत चित्रमा जलवायु परिवर्तनका सङ्केतहरू अवलोकन गरिन्छ । माथिको प्रतिशत चित्रमा काठमाडौँ उपत्यकाको गोकर्ण फर्मेसन अन्तर्गत बेसीगाउँ क्षेत्रमा भेटिएका म्याक्रोफोसिलका आधारमा प्रागवातावतरण निर्माण गरिएको देखाइएको छ (चित्र नं. ३) । यस चित्रमा BG-I, BG-2 र BG-3

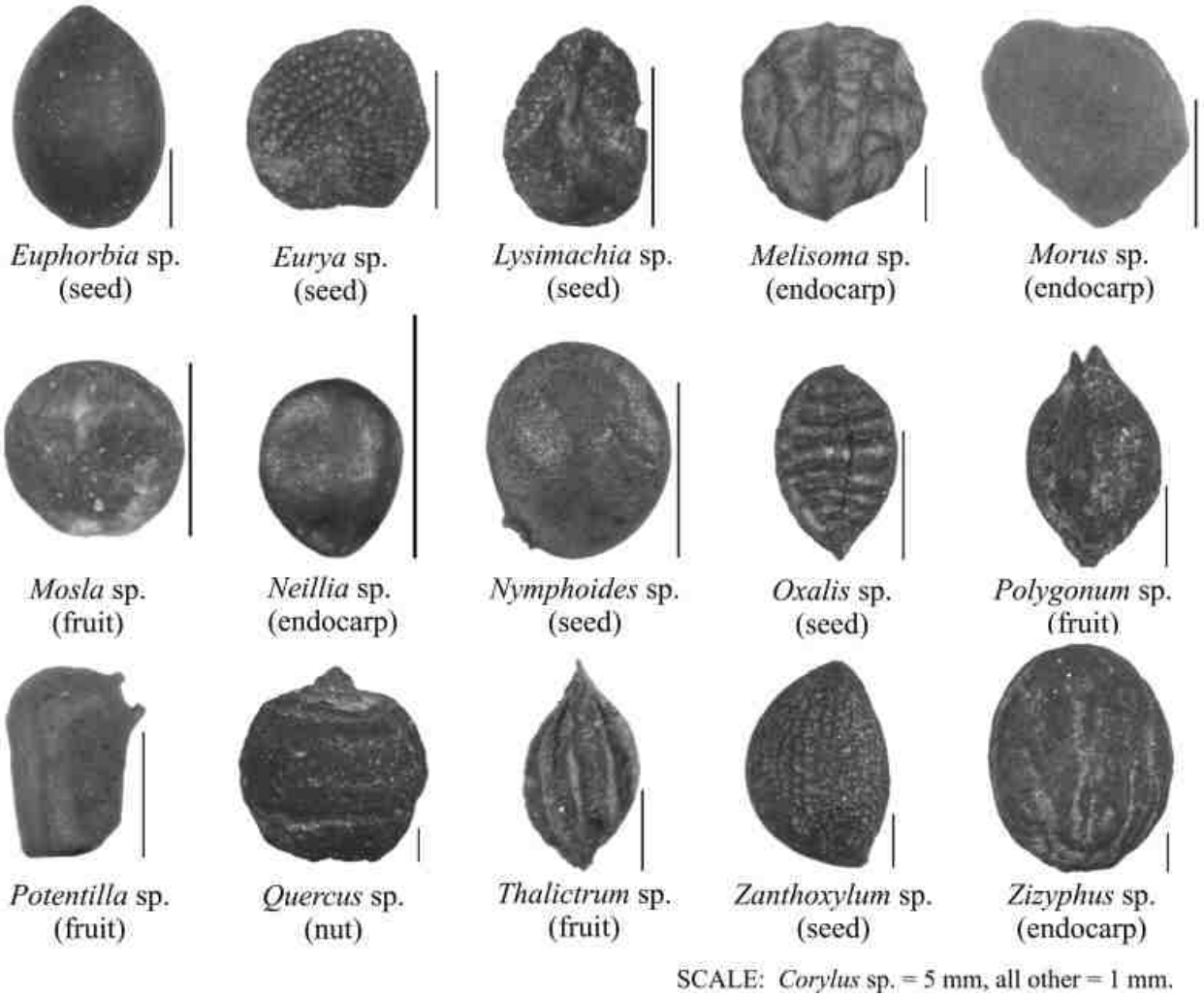


चित्र नं. ३. काठमाडौं उपत्यकाको गोकर्ण फर्मेसन अन्तर्गत बेसिगाउँ सेक्सनमा पाइएका फल र वीजका जीवावशेषका आधारमा बनाइएको प्रतिशत चित्र ।

स्याम्पल होराइजनमा उष्ण जलवायुमा हुने वनस्पतिहरूको (*Carpinus, Corylus, Eurya, Rubus, Zizyphus*) प्राधान्यता देखिन्छ भने BG-4 र BG-5 मा शीतोष्ण क्षेत्रमा पाइने वनस्पतिहरूको (*Abies, Picea, Pinus, Tsuga*) प्राधान्यता देखिन्छ । उपलब्ध प्रमुख जीवावशेषका चित्र नं. ४ (क) र (ख) मा प्रस्तुत गरिएको छ । प्राप्त वनस्पतिका जीवावशेषका आधारमा पछिल्लो क्वाटर्नरी समय वरपर (53170±820



चित्र नं. ४ (क). काठमाडौं उपत्यकाको गोकर्ण फर्मेसन अन्तर्गत बेसिगाउँ सेक्सनमा पाइएका केही प्रमुख फल र वीजका जीवावशेष ।



चित्र नं. ४ (ख). काठमाडौं उपत्यकाको गोकर्ण फर्मेसन अन्तर्गत बेसिगाउँ सेक्सनमा पाइएका केही प्रमुख फल र वीजका जीवावशेष ।

^{14}C Yrs. BP) काठमाडौं उपत्यकाको जलवायु उष्णताबाट शितोष्ण तर्फ परिवर्तन भएको निष्कर्ष निकालिएको छ (Bhandari et al., 2011b)।

निष्कर्ष

नेपालमा फल र वीजका जीवावशेष अध्ययनले भर्खर पहिलो पाइलो चालेको छ । प्रागवातावरण अध्ययनका लागि यो एउटा भरपर्दो र यथार्थपरक माध्यम (proxy) हो । क्वाटर्नरी (Quaternary) समयको प्रागवातावरण अध्ययनका क्रममा परागकण सँगसँगै उपलब्ध भएसम्मका फल र वीजका जीवावशेषको पनि अध्ययन गर्नु अपरिहार्य छ ।

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नदी पुनर्स्थापनका सैद्धान्तिक पक्ष तथा नदी वर्गीकरणको उपयोगिता

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सारांश

नदीको प्राकृतिक वातावरणमा सुधार ल्याउन सहरी नदीहरूलाई पुनर्स्थापन गर्नु आजको आवश्यकता हो । नदी वर्गीकरण प्राथमिक चरणमा गरिने कार्य भएकोले यस कार्य बिना गतिलो पुनर्स्थापन कार्य प्रायः असम्भव छ । नदी वर्गीकरण मुलतः नदीको चौडाई-गहिराई परिमाण, ढलान (slope), कटाई परिमाण (entrenchment ratio), घुमाउरोपना (sinuosity), तथा नदीको थेग्रो (sediment) को प्रकृतिलाई निरूपणगरी अपनाईन्छ । यी परिमाणहरू पत्तालगाउन तथा विश्लेषण गर्न ब्यापक अनुसन्धानात्मक अध्ययन हुनु जरुरी हुन्छ । यद्यपि पुनर्स्थापन कार्य पूर्व १) नदीमा समस्याहरू के के छन् ? २) समस्याका कारण के के हुन् ? ३) नदी कुन् बर्गमा पर्दछ र स्थाइत्वको लागि यसको प्रकार कुन् हुनु पर्दथ्यो ? ४) हालको हाइड्रोलोजी तथा थेग्रो प्रचलित पद्धति अनुरूप सम्भावित सन्तुलित नदीको बनोट कुन हुनु पर्दछ ? यिनै प्रश्नहरूको उत्तर खोजिनु पर्दछ । त्यस पछिमात्र नदीमा गरिने पुनर्स्थापन कार्य सफल हुन सक्तछ ।

परिचय

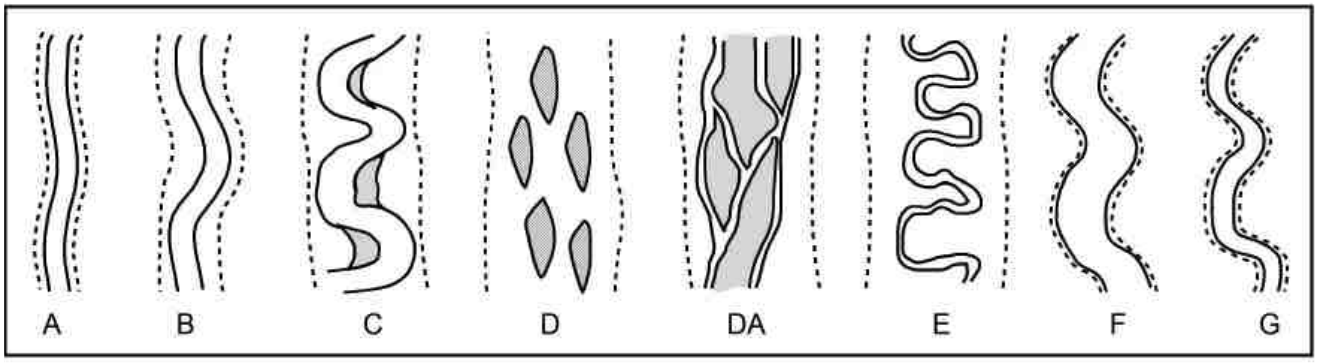
बढ्दो सहरीकरण सँगसँगै नदीको प्राकृतिक वातावरणमा असर पर्दैजाने हुनाले सहरी नदीहरूलाई पुनर्स्थापन गर्नु आजको आवश्यकता हो । पुनर्स्थापनको निमित्त ब्यापक अनुशन्धानात्मक अध्ययन हुनु जरुरी हुन्छ । त्यस क्रममा नदी वर्गीकरण प्राथमिक चरणमा गरिने कार्य भएकोले यस कार्य बिना गतिलो पुनर्स्थापना प्रायः असम्भव छ । नदी वर्गीकरण मूलतः नदीको चौडाई-गहिराई परिमाण, ढलान (slope), कटाई परिमाण (entrenchment ratio), घुमाउरोपना (sinuosity), तथा नदीको थेग्रो (sediment) को प्रकृतिलाई निरूपण गरी अपनाइन्छ । विभिन्न श्रष्टाहरूले जस्तै Leopold and Wolman (1957), Schumm (1985) तथा Rosgen (1994) ले गरेका नदीको वर्गीकरण मध्ये Rosgen (1994) को पछिल्लो वर्गीकरण अलि उच्चस्तरको र बढी उपयोगि मानिन्छ । कारण यो वर्गीकरणका निमित्त अपनाईने मापण प्रयोगात्मक र यर्थाथमा आधारित छन् । यस वर्गीकरणबाट नदीलाई झण्डै ४८ किसिमका नदीमध्ये कुनै एकथरीमा वर्गीकरण गर्न सकिन्छ । मोटामोटी रूपमा नदीलाई A, B, C, D, DA, E, F र G मा (चित्र नं १) वर्गीकरण गरिन्छन् ।

नदी वर्गीकरण कार्यले नदी पुनर्स्थापनको निमित्त गरिने अध्ययन तथा अनुसन्धानको मुख्य अंश ओगट्छ । नदी वर्गीकरण बिना कुनै पनि नदीको वास्तबिक हाईड्रोलिक स्थिति, गतिविधि तथा सन्तुलन वा समता पहिचान गर्न अत्यन्तै गाह्रो पर्दछ । नदीको वर्गीकरणबाट पुनर्स्थापनमा निम्न सहयोग पुग्दछ । जस्तै:

१) नदी तथा घांटीको बनोटबारे बिशिष्ट हाईड्रोलिक सम्बन्ध लेखाजोखा गर्न ।

२) विभिन्न परिमाण, आकृती, घांटीको निम्नता, चौडा, बहाव, जलाशयमा थेग्रोको परिमाण पद्धति इत्यादि सहित टिकाउ खालको नदी छान्नका लागि आधारशिला स्थापना गर्न ।

३) हाईड्रोलिक पारामिटर विस्तृत गर्न तथा अवरोध समिकरण र ज्यमितिय समिकरणको प्रयोगसिद्ध सम्बन्ध विकसित गर्न ।



चित्र नं १: नदीका मुख्य प्रकारको सतही दृश्य

४) श्रृंखलावद्ध घुमाउरो ज्यामितिय सम्बन्ध जुन नदी तथा किनारपूर्ण परिमाणसंग भिन्दै सम्बन्ध राख्दछकको विकास गर्न ।

५) कुनै प्रकारको नदीको सन्तुलित गुण त्यसको सन्तुलित बनोटसँग असन्तुलित अवस्थाको बनोटसँग तुलना गरी पत्ता लगाउन ।

तसर्थ नदीको वर्गीकरणबाट नदीको पुनर्स्थापनकार्यमा धेरै मद्धत् पुग्दछ । यद्यपि पुनर्स्थापन कार्य पूर्व विभिन्न मूल प्रश्नहरूको उत्तर खोजिनु पर्दछ । ति हुन्:

१) नदीमा समस्याहरू के के छन् ?

२) समस्याका कारण के के हुन् ?

३) नदी कुन् वर्गमा पर्दछ र स्थायित्वको लागि यसको प्रकार कुन् हुनु पर्दथ्यो ?

४) हालको हाईड्रोलजी तथा थेग्रो प्रचलित पद्धति अनुरूप सम्भावित सन्तुलित नदीको बनोट कुन हुनु पर्दछ ?

यिनै प्रश्नका उत्तर सर्वप्रथम विभिन्न चरणको अध्ययनबाट खोजिन्छ र त्यसपछिमात्र नदीको सन्तुलन पुन: प्राप्तिका लागि गरिने ईन्जिनियरिंग तथा बायोइन्जिनियरिङ्ग पद्धति अपनाईन्छन् ।

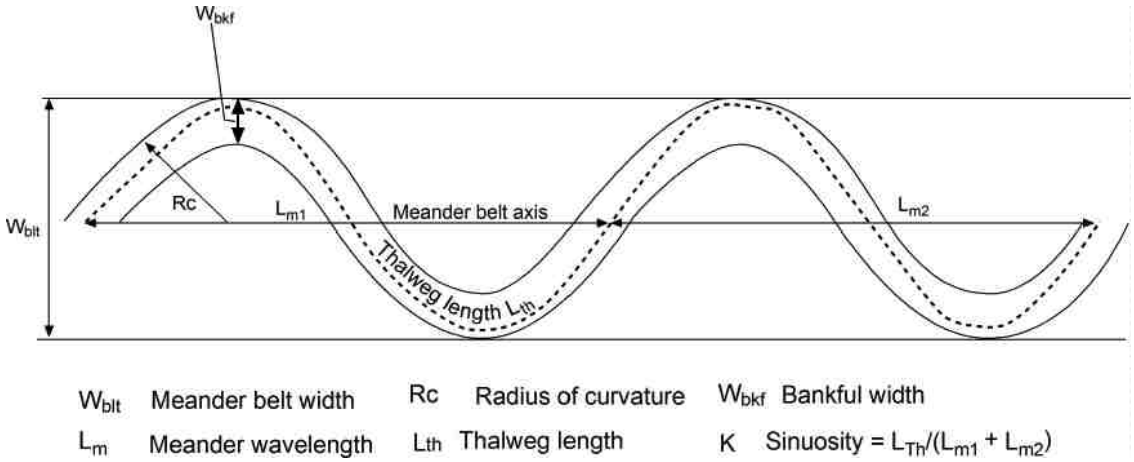
नदीमा समस्याहरू के के छन् ?

प्रथम चरणमा नदी अंशमा देखिएका समस्याबारे बिस्तृत ब्याख्या गरिनु पर्दछ । यसका लागि सन्तुलित नदी जुनसँग समस्या देखिएको नदीको जलाशयक्षत्र मिल्दा जुल्दा छन् त्यसको खोजी गरिनु पर्दछ । त्यसपछि नदी वर्गीकरणका विभिन्न चरणहरू पूरा गरी समस्याग्रस्त नदी सन्तुलित नदी स्थायित्वबाट कत्तिको बिमुख वा प्रस्थान भएको छ पत्ता लगाउन सकिन्छ । यसका साथै विभिन्न समस्याहरूको वर्गीकरण र ब्याख्या गर्न मद्दत पुग्दछ ।

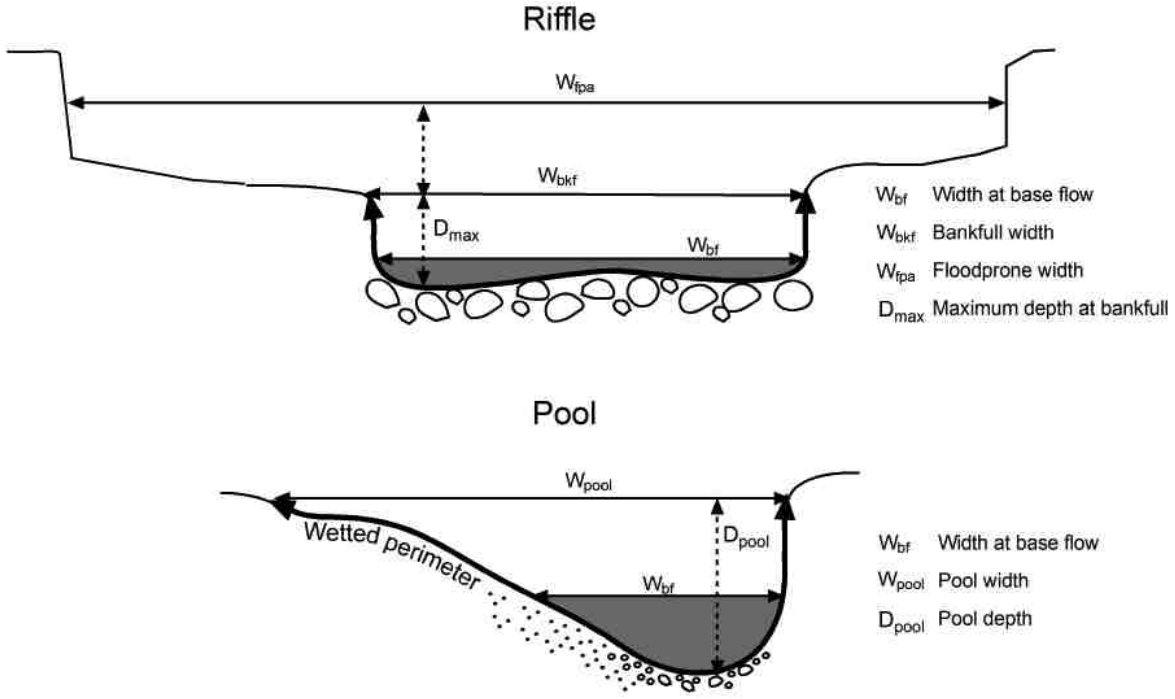
समस्याहरूका कारण के के हुन् ?

समस्याहरूका कारणको खोजीगर्न जलाशयमा अहिलेको र पुरानो भूमि सञ्चालनको पुननिरीक्षण गरिनु पर्दछ । जलाशयमा समयानुसार परिवर्तन आउने नदी वहावको परिमाण तथा समयान्तरले नदी पद्धतिमा उर्जाको मात्रा तथा वितरणमा असर पार्दछ । चट्टानलाई कटान् गरी बग्ने नदीमा पर्ने असर थेग्रो कटान् गरी बग्ने नदीमा पर्ने असर भन्दा भिन्न हुन्छ । अस्थिर नदीको पुनर्स्थापनका खाकाहरू वा डिजाईन बनाउनुपूर्व नदीको असन्तुलित अवस्थाका कारणहरू पत्तालगाउनु पर्दछ । यी कारणहरू जटिल तथा विभिन्न जलाशयका पद्धतिसित अन्तरनिहित हुनसक्तछ । जलाशयमा आउने परिवर्तनहरू जसबाट नदीको बहाव परिमाण तथा समयान्तरमा प्रत्यक्ष असर पर्दछ ती भनेका वानस्पतिक विनाश, बाटोघाटोको जथाभाबि निर्माण, माटोको सुदृढिकरण, बहाव नियन्त्रण, बढ्दो शहरीकरण इत्यादि हुन् । यस अलावा थेग्रोको स्रोत, प्रकृति, परिमाण इत्यादिमा परिवर्तन आउनाले पनि नदीको सन्तुलनमा ब्यापक असर पर्दछ ।

नदीको सन्तुलन र जलाशयमा हुने परिवर्तनको बिचको अन्तरसम्बन्ध बुझ्नु जरुरी हुन्छ । यदि जलाशयमा पानीको सतही बहावको बृद्धि (बस्तीको बृद्धिबाट हुने) बाट नदीको क्षणिक बहावमा बृद्धि भयो भने त्यसको असर सोझै नदीको चौडाई बृद्धि भई त्यस बहावलाई तथस्ट पारी सन्तुलन कायम् राख्ने खाल्को हुन्छ । यसरी चौडाई बृद्धि हुने क्रममा नदीको किनारमा क्षयिकरण हुने, नदीको किनारपूर्ण चौडाई, घुम्तीय ज्यामिती तथा यससँग अन्तरनिहीत घुम्तीको लम्बाई, अर्धव्यास चक्राकार तथा घुम्ती चौडाई परिमाणमा (चित्र नं २) समेत परिवर्तन आउंदछ । यस खालको जलाशयमा परिवर्तन र त्यसबाट नदीमा परेका असरबारे Tamrakar (2004), Bajracharya (2006), Shrestha and Tamrakar (2007), Bajracharya and Tamrakar (2008) Tamrakar and Bajracharya (2009) तथा Shrestha et al. (2010) अध्ययन गरेका छन् ।



चित्र नं २: नदीको ज्यामितीय परिमाणहरू दर्शाइएको



चित्र नं ३: नदीको हाईड्रोलिक परिमाणहरू दर्शाइएको

नदीको प्रकार कुन् हुनु पर्दथ्यो ?

पुनर्स्थापन गर्नुपर्ने नदीलाई त्यसको हालको क्षयिकरण अवस्थामा हेरिनुको साथसाथै भविष्यमा जलाशयमा हुदैजाने परिवर्तन विकसित हुदैजाने नदीको रूपमा समेत हेरिनु पर्दछ । तसर्थ कुन खालको नदी त्यस्तो खालको हुन सक्तछ त्यसको निर्क्यौल गर्नु पर्दछ । त्यसपश्चात नदीको स्थिर परिमाण, प्रकार र प्रोफाईल स्थापित गरिनु पर्दछ । यसका लागि ज्यामिती (चित्र नं २) तथा हाईड्रोलिक परिमाणहरू (चित्र नं ३) नमूना नदीअंशबाट तथा गेज स्टेशनहरूबाट प्राप्त गरिन्छ ।

सम्भावित सन्तुलित नदीको बनोटमा कसरी ढालिन्छ ?

उपयुक्त हुने सन्तुलित तथा प्राकृतिक नदी बनोट विकसित गर्न कठीन हुन्छ । तर यसको निमित्त नदीको वर्गीकरणले सम्भावित पुनर्स्थापन गरिने नदीको स्थिर चौडाइ उचाई परिमाण (नमूना अंशबाट प्राप्त) स्थापित गर्न मद्दत पुरयाउँदछ । जसको मद्धत्बाट हाईड्रोलिक ज्यामितिको आधारमा किनारपूर्ण वहावसंग निहित किनारपूर्ण नदीको चौडा क्षत्रफल (cross-sectional area) को आधारबाट पुनर्स्थापन गरिने किनारपूर्ण चौडाई निकालिन्छ । यसरी निकालिएको किनारपूर्ण चौडाईको सहयोगबाट घुम्तीय लम्बाई, नदीको पेटीको चौडाई, घुमाउरोपना (sinuosity), निम्नता (slope), इत्यादि पनि पत्ता लगाईन्छ । यिनै परिमाणसित मिल्नेगरी समस्याग्रस्त नदीअंशलाई पछि परिवर्तन गरिन्छ ।

कस्तो नदीमा पुनर्स्थापन कार्य गनु जरुरी हुन्छ ?

नदीमा परेका समस्याका मूल जरो पत्ता नलगाई वा नबुझी गरिने पुनर्स्थापन कार्य बिफल हुन सक्तछ । कारण यस प्रकारका कार्यबाट नदीको बिस्तृत सन्तुलनमा असर पर्न गई कालान्तरमा झन बढी असर पर्न सक्तछ । तसर्थ नदीको कम्तीमा पनी जलपूर्ण बहाव, थेग्रो प्रचलित पद्धति, जलाशयमा नदीको हाईड्रोग्राफको विशेषता इत्यादि बारे जानकारी लिनु आवश्यक हुन्छ । यस अलावा जलाशयमा आउने परिवर्तन जस्तै: भूपरिचालनमा आउने परिवर्तन तथा मानव दखलबाट आउने परिवर्तनको पनि जानकारी राख्नु पर्दछ । समग्रमा नदी एक खाल्को शक्तीयुत्त पद्धति भएको हुनाले यसको कुनैपनि अंशमा गरिने कार्यले कालान्तरमा उपल्लोधार र तल्लो धारमा असर पुरयाउंदछ । त्यसैले पुनर्स्थापन गरिने नदीमा निम्न गुणदोष देखिएको हुनु पर्दछ ।

१) जुन नदी चौडाई गहिराई परिमाण तथा कटाई परिमाणमा सन्तुलित नदी अंशबाट अत्याधिक बिमुख हुन पुग्दछ।

२) जुन नदीको चौडाई गहिराई परिमाण सितथेग्रो पद्धतिको सम्बन्ध स्थाईत्वबाट अत्याधिक बिमुख हुन पुग्दछ ।

३) जुन नदीको घुम्ती चौडाइ तथा घुम्ती लम्बाई त्यस नदीको किनारपूर्ण चौडाईसितको सम्बन्धबाट अत्याधिक बिमुख हुन पुग्दछ ।

यसर्थमा पुनर्स्थापन कार्य अपनाउनु अगाडी गरिने अध्ययन कार्य आफैमा पनि चुनौतियुक्त छ । यसका निमित्त दक्ष जनशक्तिको साथै अनुशन्धानमुलक अध्ययन अध्यापन मा बढी केन्द्रीत हुन आवश्यक छ ।

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नेपालमा भूगर्भशास्त्र शिक्षाको वर्तमान अवस्था र भावी दिशा

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सारांस

भूगर्भशास्त्र बैज्ञानिक अनुसन्धानका हिसावले चाखपूर्ण र ब्यवहारिक, र रोजगारीका हिसाबले सम्भावनायुक्त विषय भए तापनि नेपालको हालको शिक्षा प्रणालीमा यस विषयले महत्व पाउन सकेको छैन । यस लेखमा नेपालमा हाल भूगर्भशास्त्र विषय शिक्षाको अवस्था र यसको विकासका लागि भूगर्भविद्हरूले गर्नुपर्ने कामका बारेमा विश्लेषण तथा सुझाउ प्रस्तुत गरिएको छ ।

भूमिका

भूगर्भशास्त्र पृथ्वीको बाहिरी सतहको बनावट (जस्तै पहाड, नदी, मैदान र उपत्यकाहरू), भौगोलिक प्रकृयाहरू (पहिरो भू-क्षय, भूकम्प, ज्वालामुखी), खनिज, चट्टान, माटो, भूमिगतजल, पृथ्वीको संरचना, प्लेटहरूको संरचना तथा गति, पहाडहरू उठ्ने प्रकृया, जीवको इतिहास तथा विकासक्रम, वातावरण परिवर्तन, प्राकृतिक प्रकोप व्यवस्थापन इत्यादिका बारेमा अध्ययन तथा अनुसन्धान गर्ने विधा हो । पृथ्वीमा देखिनअचम्म लाग्ने बनावटहरू जस्तै उच्च पहाड, समथल मैदान, गहिरा गल्छी, रहस्यमय गुफा र तिनमा भएका आकृतिहरू, तातो पानीका मूल र भूकम्प आदिको वास्तविकता र वैज्ञानिक कारण, पृथ्वीको इतिहासका विभिन्न कालखण्डहरूमा भएका घटनाहरू आदि भूगर्भशास्त्र विषयको अध्ययन अनुसन्धानवाट थाहा हुन्छ । त्यसैगरी मानव जीवनमा प्रत्यक्ष उपयोगमा आउने खनिजको खोज तथा उत्खनन् कार्य पनि भू-वैज्ञानिकहरूले नै गर्दछन् । त्यसैगरी ठूलाठूला इन्जिनियरिङ्ग बनावट जस्तैः बाँध, पुल, बाटो, सुरुङ्ग आदि निर्माण गर्नु अगाडि उपयुक्त ठाउँको छनौट गर्नेकाम समेत भू-वैज्ञानिकहरूले गर्दछन् । यसकारण भूगर्भशास्त्र विशुद्ध वैज्ञानिक खोजतलासको विषयमात्र नभएर मानव जीवनमा प्रत्यक्ष रूपमा प्रयोग हुने विषय हो । यस विषयको अध्ययनको दायरा निकै ठूलो छ । भौतिकशास्त्र देखि गणित, जीवविज्ञानदेखि रसायनशास्त्र, इन्जिनियरिङ्ग देखि अर्थशास्त्रसम्मका विषयहरूको भू-विज्ञान विषय अध्ययनमा प्रयोग हुन्छ । रोजगारीका हिसाबले भूगर्भशास्त्र अध्ययन गरेका भूवैज्ञानिकहरू नेपालका विभिन्न सरकारी तथा गैह्रसरकारी निकायहरू, जस्तैः खानी तथा भूगर्भ विभाग, विद्युत प्राधिकरण, जल-उत्पन्न प्रकोप नियन्त्रण विभाग, सिंचाई विभाग, भूमिगत जल विकास बोर्ड, जल तथा शक्ति आयोगका साथै खनिज अन्वेषण, सिमेण्ट कारखाना, सवै खाले जलविद्युत परियोजनाहरू, सुरुङ्ग निर्माण, बाँध निर्माण, नहर र सडक निर्माणका साथै रोडा-ढुङ्गा उद्योग र बाढी-पहिरो नियन्त्रणमा कार्यरत छन् । उल्लेखित बाहेक अन्य ठाउँहरूमा समेत पर्याप्त भूगर्भविद्हरू नभएको स्थिति छ । भविष्यमा बुढीगण्डकीजस्ता ठूला जलविद्युत् आयोजनाहरू निर्माणकार्य सुरू भएमा एउटै आयोजनामा १०-१५ जना भूगर्भविद्हरू आवश्यक पर्ने देखिन्छ । यस्तो अवस्थामा भूगर्भविद्हरूको अभाव झन् बढ्दै जाने देखिन्छ ।

यसर्थ भूगर्भ शास्त्र विषय बैज्ञानिक अनुसन्धानका हिसावले चाखपूर्ण छ, मानव जीवनका हरेक व्यावहारिक पक्षमा प्रयोगमा आउने र रोजगारीका हिसाबले पनि सम्भावनायुक्त विषय हो । तर दुःखलाग्दो कुरा के छ भने यस्तो चाखलाग्दो, व्यावहारिक र रोजगारमुलक विषयको शिक्षा नेपालमा साह्रै निरीह र अवस्था रहेको छ । यस विषयको अध्ययन अनुसन्धान नेपालमा हुन्छ भन्ने सम्म पनि कतिपय मानिसलाई थाहा छैन । कतिसम्म भने धेरै मानिसलाई Gealogy (भूगर्भ), Geography (भूगोल) र Zoology (प्राणीशास्त्र) विषयको भिन्नतामा समेत अलमल रहेको देखिन्छ ।

यसका प्रमुख कारणहरूमा नेपालको हालको शिक्षा प्रणालीमा भूगर्भ शास्त्र विषयले महत्व नपाउनु नै हो । यस लेखमा नेपालमा हाल भूगर्भ शास्त्र विषय शैक्षिक अवस्थाको र यसको सुधारका लागि अव हामीले गर्नुपर्ने कामका बारेमा विश्लेषण तथा सुझाउ प्रस्तुत गरिएको छ ।

भूगर्भशास्त्र पठनपाठनको वर्तमान अवस्था

विद्यालय तह

विद्यालय तहको शिक्षामा भूगर्भ विषय सबैभन्दा कमजोर अवस्थामा रहेको छ । हाल स्कुल स्तरमा कक्षा २ देखि १० सम्मका विज्ञान विषयमा केही मात्रामा पृथ्वीको बनोट, भौगर्भिक इतिहास तथा चट्टानसम्बन्धी पाठ समावेश गरिएको छ । तर भूविज्ञान विषयको भार अन्य विषय जस्तै भौतिक शास्त्र, रसायन शास्त्र, र जीव शास्त्रको तुलनामा निकै कम रहेको छ । हालको विद्यालय स्तरको पाठ्यक्रममा विज्ञान पुस्तकको जम्मा पेज सङ्ख्या र भूविज्ञान विषयले ओगटेको पेज सङ्ख्या तलको तालिकामा दिइएको छ (तालिका १) । तालीकाबाट स्कूल स्तरमा भूविज्ञान विषयले धेरैजसो कक्षामा ५% भन्दा कम भार ओगटेको देखिन्छ । जब कि अन्य विषयको भार ३०% भन्दा बढी छ । पठ्यक्रम पनि धेरैजसो कक्षामा उही विषयबस्तु दोहोराएर राखिएको छ । नेपालको खनिजस्रोत जस्तो महत्वपूर्ण विषय कुनै पनि तहका पाठ्यक्रममा समावेश गरिएको देखिँदैन ।

निजी तथा सरकारी स्कुलका पाठ्यपुस्तकमा समावेश भूविज्ञानसँग सम्बन्धित सीमित पाठमा समेत प्रशस्त त्रुटिहरू रहेका छन् । उदाहरणका लागि कक्षा १० मा पृथ्वीको भौगर्भिक समय तालिका (Geological Time Scale) समावेश गरिएको छ । अन्तर्राष्ट्रिय मान्यता अनुसार

तालिका १: हालको विद्यालय स्तरको पाठ्यक्रममा भूविज्ञान विषयले ओगटेको पेज सङ्ख्या र विषयबस्तु तथा विज्ञान पुस्तकको जम्मा पेज सङ्ख्या

कक्षा	पाठ्यक्रम	पुस्तकको जम्मा पेज
१	छैन	८२
२	जमिन र पानी, डाँडा र मैदान (१ पेज)	७८
३	पृथ्वी (आकार, पहाड, मैदान, उपत्यका, चट्टान, माटो आदि) (३ पेज)	१४०
४	पृथ्वी (आकार, पहाड, मैदान, उपत्यका, जलमण्डल आदि) (४ पेज)	१६३
५	पृथ्वी (आकार, पहाड, मैदान, भित्री बनोट, सतहमा हुने परिवर्तन आदि) (४ पेज)	१६२
६	पृथ्वी, पहाड, मैदान, उपत्यका, चट्टान आदि (६ पेज)	१७८
७	पृथ्वीको भित्री बनोट र भूक्षय (११ पेज)	१४६
८	चट्टानका किसिम र बनोट, माटो, ज्वालामुखी (१० पेज)	१७२
९	प्राकृतिक प्रकोप (बाढी, पहिरो, सामुद्रिक आँधी, ज्वालमुखी, भूकम्प) (२२ पेज)	२६६
१०	पृथ्वीको इतिहास (भौगर्भिक समय तालिका र जीवावशेष) (९ पेज)	२५७

भौगर्भिक समय तालिकामा जहिले पनि पुरानो समयलाई अन्तमा र नवीन समयलाई सुरुमा राखिन्छ। तर कक्षा १० को विज्ञान विषयको पाठ्यक्रममा दिइएको उक्त समयतालिका ठीक उल्टो छ (चित्र नं. १)। यसरी बालबालिकाहरूलाई स्कुलबाटै उल्टो शिक्षा प्रदान गरिराखिएको छ। त्रिभुवन विश्वविद्यालयमा कार्यरत भूगर्भ विषयका वरिष्ठ प्राध्यापक समेत संलग्न भई लेखिएका पुस्तकहरूमा यस्ता त्रुटी हुनु बिडम्बना मान्नु पर्दछ।

यस्ता अन्य धेरै त्रुटिहरू छन् र तलको तालिकामा (तालिका २) केही साङ्केतिक उदाहरणहरू मात्र प्रस्तुत गरिएको छ।

निजी प्रकाशकहरूबाट प्रकाशित पाठ्यपुस्तकमा भएका त्रुटिका बारेमा त झन् उल्लेख गरिसाध्य छैन। उदाहरणका लागि Unique Educational Publisher द्वारा प्रकाशित कक्षा ५ को विज्ञानको पाठ्यपुस्तकमा चट्टानलाई खनिज र खनिजलाई चट्टानका रूपमा फोटोसहित प्रस्तुत गरिएको छ (चित्र नं. २)।

यस्ता पाठ्यपुस्तकबाट हाम्रा बालबालिकाहरूले कस्तो शिक्षा लिइरहेका होलान् सहजै अनुमान गर्न सकिन्छ। यी पाठ्यपुस्तकका त्रुटिहरू थाहापाउने क्षमता भएका शिक्षक विद्यालय तहमा छैनन् किनभने ती शिक्षकले भूगर्भ विषय पढेका हुँदैनन्। अर्को कुरा किताब नै नसच्याएसम्म एक दुई शिक्षकले सच्याएर पढाउँदा विद्यार्थीका लागि स्थिति झन् प्रत्युत्पादक हुन सक्ने हुनाले सच्याएर पढाउने अवस्था पनि छैन।

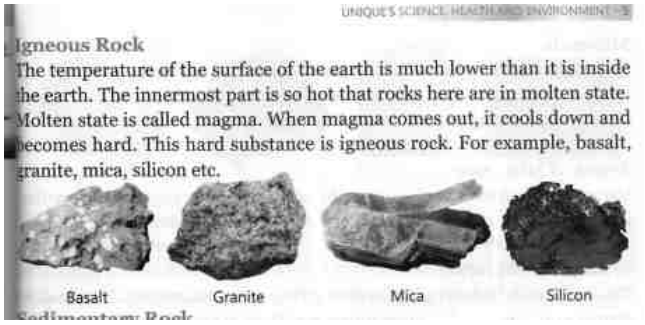
तालिका : भौगर्भिक युग तथा जीव विकासको क्रम

इयोन(Eon)	महाकल्प (Era)	काल (Periods)	युग (Epoch)	अवधि (वर्षमा)	जीवको प्रादुर्भाव
Cryptozoic or Pre-cambrian	Archean			4 अरब 50 करोड वर्ष अघिदेखि 2 अरब 50 करोड वर्ष अघिसम्म	पृथ्वीको उत्पत्ति
	Proterozoic			2 अरब 50 करोड वर्ष अघिदेखि 54 करोड वर्ष अघिसम्म	धेरै पुरानो एक कोषीय साधारण जीवाणुको उत्पत्ति, पछि बहुकोषीय जीवहरूको विकास
Phanerozoic	पूराजीव (Palaeozoic) 54 करोड वर्षअघिदेखि 25 करोड वर्षअघिसम्म	क्याम्ब्रियन (Cambrian)		54 करोड वर्ष अघिदेखि 49 करोड वर्ष अघिसम्म	केही सामुद्रिक जीवको विकास
		अर्डोभिसियन (Ordovician)		49 करोड वर्ष अघिदेखि 44 करोड वर्ष अघिसम्म	समुद्रमा पहिलो ढाड भएका जीवहरूको विकास
		सिलुरियन (Silurian)		44 करोड वर्ष अघिदेखि 42 करोड वर्ष अघिसम्म	पहिलो स्थल र हरिया वनस्पति तथा माछाको उत्पत्ति र विकास
		डेभोनियन (Devonian)		42 करोड वर्ष अघिदेखि 36 करोड वर्ष अघिसम्म	पखेटा भएका किराहरूको उत्पत्ति, माछाको विकास र बिरुवाको उत्पत्ति र विकास

चित्र नं. १: शिक्षा मन्त्रालयद्वारा प्रकाशित कक्षा १० को विज्ञान किताबमा दिइएको भौगर्भिक समयतालिका। यो ठीक उल्टोसाग प्रस्तुत गरिएको छ।

तालिका २: विद्यालयस्तरको पाठ्यक्रममा समावेश भूविज्ञान विषयमा देखिएका केही त्रुटिहरूका उदाहरण ।

प्रकाशक	कक्षा	पेज	पाठ शिर्षक	समाविष्ट विषय वस्तु	समस्या
शिक्षा मन्त्रालय	१०	२२९	पृथ्वीको इतिहास	Geological time scale	उल्टो
शिक्षा मन्त्रालय	५	७०	पृथ्वी	क्रष्टको मोटाइ ७५ कि.मि.	कक्षा ७ को पेज १२२ मा क्रष्टको मोटाइ ५ देखि ५० मिटर दिइएको छ ।
Unique Educational Publishers	५	१५९	Rcks and Minerals	Igneous Rocks : Mica and Silicon	माइका र सिलिकन Rock नभई Mineral हुन् ।
Unique Educational Publishers	५	१६१	Rocks and Minerals	Non metallic minerals : Marble, Limestone, Sand	मर्वल र चुनढुङ्गा चट्टान हुन्, बालुवा धेरै किसिमका खनिजको मिश्रण हो ।



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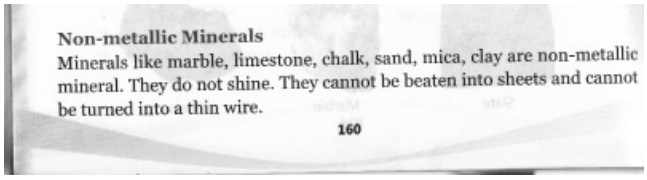


(ख)

चित्र नं. २: युनिक एजुकेसनल पब्लिसर (Unique Educational Publisher) द्वारा प्रकाशित कक्षा ५ को किताबमा भएका केही त्रुटिका उदाहरण । (क) अभ्रक (Mica) र (Silicon) जुन खनिज हुन् तिनलाई आग्नेय चट्टान (Igneous Rocks) को रूपमा चित्रसहित दिइएको छ । (ख) मार्बल (Marble) र चुनढुङ्गा (Limestone) जुन चट्टान हुन् तिनलाई खनिजको रूपमा र क्ले (Clay) र स्याण्ड (Sand) जुन सेडिमेन्ट (Sediment) हुन् तिनलाई पनि खनिजको रूपमा प्रस्तुत गरिएको छ ।

उच्चमाध्यमिक तह

उच्च माध्यामिक तहमा हाल सम्म भूगर्भशास्त्रका कुनैपनि पाठ्यक्रम समावेश गरिएको छैन । रसायन शास्त्र विषयमा केहि खनिजका नाम जस्तै limestone, dolomite, hematite, magnetite, आदिका नाम बाहेक अन्य कुरा विद्यार्थीले सुन्न समेत पाउँदैनन् ।

विश्वविद्यालय तह

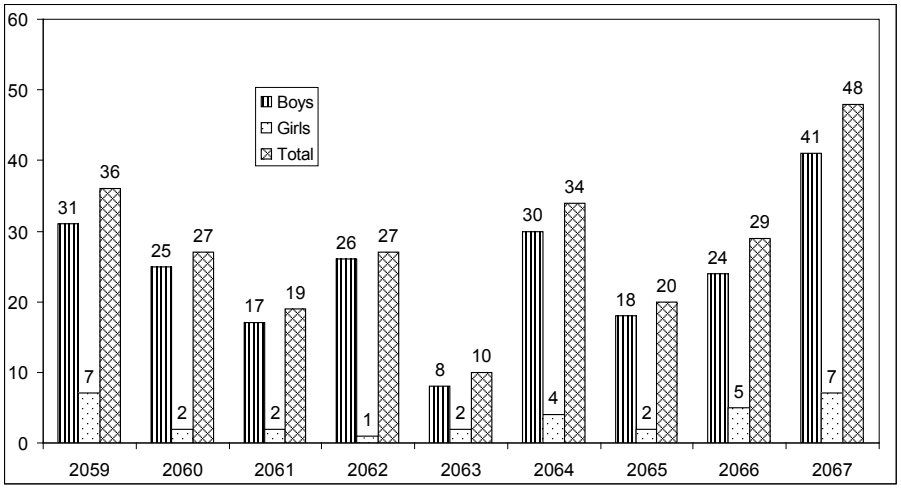
नेपालमा भौगर्भिक जनशक्ति उत्पादन गर्ने एकमात्र संस्था भनेको त्रिभुवन विश्वद्यिालय हो । त्रिभुवन विश्वद्यिालयमा भूविज्ञान र खनिज सम्बन्धी शिक्षा दुईवटा स्थानमा मात्र दिइन्छ: त्रि-चन्द्र क्याम्पसमा स्नातक तह र भूगर्भ केन्द्रीय विभाग कीर्तिपुरमा स्नातकोत्तर तथा विद्यावारिधि तह ।

स्नातक तह

नेपालमा स्नातक तहमा भूगर्भशास्त्रको पठन-पाठन सर्वप्रथम २०२४ सालमा त्रि-चन्द्र कलेजमा प्रारम्भ भएको हो । गएको ३८ वर्ष सम्म यही क्याम्पसमा मात्र स्नातक तहमा अध्यापन भइरहेको छ र हाल सम्म पनि अन्य क्याम्पसमा भूगर्भशास्त्र विषयको स्नातक तह विस्तार हुन सकेको छैन ।सुरूका वर्षहरूमा विद्यार्थीहरू नगन्य मात्रमा आएता पनि पछिल्लो दशकमा स्नातक तहमा विद्यार्थीहरूको सङ्ख्या विस्तारै बढ्दै गएको छ । हाल त्रि-चन्द्र क्याम्पसमा स्नातक तह प्रथम वर्षमा वार्षिक सरदर ३०-५० जना विद्यार्थी भर्ना हुन्छन् । द्वितीय र तृतीय वर्षसम्म आइपुग्दा उक्त सङ्ख्या घट्दै जान्छ र सरदर वार्षिक २० देखि ३० जनाले मात्र स्नातक तह पूरा गर्छन् (चित्र नं. ३) । यो वर्ष स्नातक प्रथम वर्षमा विद्यार्थीको सङ्ख्या अत्याधिक बढेको देखिन्छ । त्रि-चन्द्र कलेज भूगर्भशास्त्र विभाग स्रोत अनुसार अहिले प्रथम वर्षमा करिव ३०० जना विद्यार्थी भर्ना भएका छन् । विद्यार्थी युनियनको चुनावको हल्लाले भर्नामा केही प्रभाव पारेको भएता पनि प्रमुख कारण भूगर्भशास्त्र विषयप्रतिको विद्यार्थीको आकर्षण नै हो ।

स्नातकोत्तर तह

त्रिभुवन विश्वविद्यालयमा स्नातकोत्तर तहका कक्षाहरू २०३२ सालबाट त्रि-चन्द्र कलेजमा नै सुरू गरिएको हो । २०३२ देखि २०४२ साल सम्म १० वर्ष यही कलेजमा स्नातकोत्तर तह सञ्चालन भयो । २०४२ साल देखि स्नातकोत्तर तहका कक्षाहरू त्रिभुवन विश्वविद्यालयको कीर्तिपुर केन्द्रीय क्याम्पसमा स्थानान्तर गरियो । केन्द्रीय क्याम्पस कीर्तिपुरलाई उत्कृष्टता केन्द्रको (Centre for Excellence) रूपमा विकास गर्ने सोच अनुरूप



चित्र नं. ३: त्रि-चन्द्र क्याम्पस, भूगर्भशास्त्र शिक्षण समितिमा २०५९ देखि २०६७ सालसम्म स्नातक तह तृतीय वर्षमा भर्ना भएका विद्यार्थीहरूको तथ्याङ्क। (स्रोत: त्रि-चन्द्र क्याम्पस, प्रशासन शाखा)।

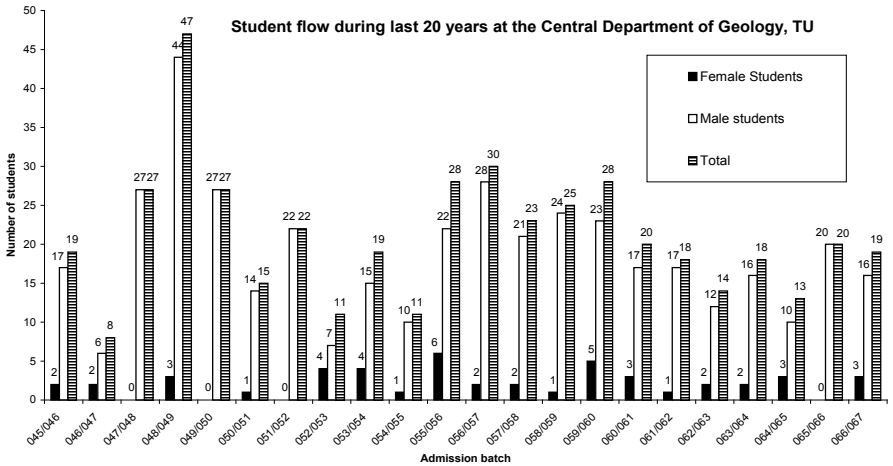
स्नातकोत्तर तहका कक्षालाई कीर्तिपुर केन्द्रीय क्याम्पसमा स्थानान्तर गरिएको थियो। सोही समयदेखि त्यहाँ विद्यावारिधि (पीएच.डी.) को कार्यक्रम पनि प्रारम्भ भयो। भूगर्भशास्त्र केन्द्रीय विभागले हालसम्म झण्डै ५०० जना स्नातक तहका भूगर्भविद्हरू उत्पादन गरिसकेको छ भने हालसम्म ४ जनाले यस विभागबाट विद्यावारिधी हासिल गरिसकेका छन्।

स्नातक तहको अध्यापन त्रि-चन्द्र क्याम्पसमा मात्रै सीमित हुनाले यहाँ स्नातकोत्तर पढ्न आउने विद्यार्थीको सङ्ख्या सधै अत्यन्त न्यून छ। भूगर्भशास्त्र केन्द्रीय विभाग कीर्तिपुरमा स्नातकोत्तर तहमा वार्षिक सरदर २० जना मात्र विद्यार्थी भर्ना हुन्छन् (चित्र नं. ४)। यस विभागको क्षमता वार्षिक २५ जना विद्यार्थीलाई पढाउन सक्ने भए पनि हालसम्म क्षमता अनुसार विद्यार्थी भर्ना नभएको स्थिति छ।

भावी दिशा

विद्यालय र उच्च माध्यमिक तहमा भूगर्भशास्त्र विषय समावेश गर्न पहल गर्ने

जनस्तरमा भूगर्भशास्त्र सम्बन्धी चेतना अभिवृद्धि गर्न र देशमा रहेका खनिज स्रोतहरूको बारेमा सर्वसाधारणलाई जानकारी दिनको लागि विद्यालय स्तरको पाठ्यक्रममा समसामयीक सुधार गर्नु, यसमा रहेका त्रुटीहरू सच्याउनु र भौतिकविज्ञान, रसायनविज्ञान र जीवविज्ञानको अङ्कभार जति छ भूगर्भशास्त्रको अङ्कभार पनि त्यतिनै बनाउनु जरूरी छ। नेपालको नयाँ संविधान जारी भएपछि सम्भवत: विद्यालय स्तरको पाठ्यक्रममा परिमार्जन हुनेछ। भूगर्भशास्त्र विषयको पाठ्यक्रम स्कूल स्तरमा थप गर्ने यो उपयुक्त समय हुन सक्छ। तसर्थ हामीबाट अहिले



चित्र नं. ४: भूगर्भशास्त्र केन्द्रीय विभागमा स्नतकोत्तर तहमा २०४५ देखि २०६६ सालसम्म भर्ना भएका विद्यार्थीहरूको तथ्याङ्क। (स्रोत: भूगर्भशास्त्र केन्द्रीय विभाग, प्रशासन शाखा)।

देखि नै यसको तयारी हुनु जरूरी छ। यसका लागि राष्ट्रपति, प्रधानमन्त्री, शिक्षमन्त्री लगायत सम्बन्धित राजनीतिक र प्रशासनिक नेतृत्व समक्ष समयमै कुरा राख्ने र भूविज्ञानको महत्वका वारेमा उनीहरूलाई बुझाउन सक्नु पर्दछ। यसैगरी उच्च माध्यमिक तहमा पनि भूगर्भशास्त्र विषय समावेश गर्न पहल गर्न जरूरी छ।

भूगर्भशास्त्र स्नातक तहको पठनपाठन अन्य ठाउँमा विस्तार गर्ने

त्रिभुवन विश्वविद्यालय, विज्ञान तथा प्रविधि अध्ययन संस्थान अन्तर्गत भौतिकशास्त्र विषयमा ३४ ठाउँमा स्नातक र ९ ठाउँमा स्नातकोत्तर, रसायनशास्त्रमा ३४ ठाउँमा स्नातक र ४ ठाउँमा स्नातकोत्तर, शुक्ष्मजीव विज्ञानमा २८ ठाउँमा स्नातक र ८ ठाउँमा स्नातकोत्तर, र वातावरण विज्ञानमा १६ ठाउँमा स्नातक र ४ ठाउँमा स्नातकोत्तर कक्षा सञ्चालन भैरहेका छन्। तर भूगर्भशास्त्रको भने स्नातक र स्नातकोत्तर कक्षा एक/एक ठाउँमा मात्र सञ्चालन भैरहेका छन्। त्रिभुवन विश्वद्यिालयमा भूगर्भशास्त्र विषयको स्नातक कक्षा सञ्चालन भएको ३८ वर्ष सम्म पनि अन्य क्याम्पसमा स्नातक तह विस्तार नहुनु अनौठो हो।

तसर्थ अहिलेको हाम्रो प्राथमिकता स्नातक तहको पठनपाठन अन्य क्याम्पसहरूमा विस्तार गर्नु हुनुपर्दछ। भूगर्भशास्त्र केन्द्रीय विभाग यसतर्फ पहल गरिसकेको छ र यसै वर्षदेखि वीरेन्द्र बहुमुखी क्याम्पस, भरतपुर र पृथ्वीनारायण बहुमुखी क्याम्पस पोखरामा स्नातक तह शुरू हुँदैछ। दुवै ठाउँमा यस वर्ष ४०/४० जना विद्यार्थी भर्ना गरिने योजना रहेको छ।

यसरी नै अर्को वर्ष अन्य १/२ ठाउँमा (पूर्व र सुदूर पश्चिम) स्नातक तह विस्तार गर्न जरूरी देखिन्छ। यसको लागि भूगर्भशास्त्र केन्द्रीय विभागले आवश्यक पहल गर्नेछ।

स्नातकोत्तर तहको पाठ्यक्रममा समसामयीक परिमार्जन गर्ने

देशमा आवश्यक जनशक्ति र विश्वमा भैरहेका अनुसन्धानात्मक कार्यलाई ध्यानमा राखी भूगर्भशास्त्र विषय समितिले स्नातक र स्नातकोत्तर तहको पाठ्यक्रममा समयसमयमा आवश्यक परिमार्जन गर्दै आइरहेको छ। हाल उत्पादित जनशक्ति विषेशगरी Engineering Geologist, Exploration and Mining Geologist र Hydrogeologist को रूपमा काम गरिरहेको परिप्रेक्षमा रोजगार क्षेत्रको माग बमोजिम यस वर्षदेखि नै लागू हुनेगरी भूगर्भशास्त्र विषय समितिले स्नातकोत्तर तहको पाठ्यक्रममा माथिका तिन विशेषज्ञता हासिल गर्ने गरी पाठ्यक्रम परिमार्जन गरिसकेको छ। परिमार्जित पाठ्यक्रम तालिका ३, ४, ५ र ६ मा दिइएको छ।

परिमार्जित पाठ्यक्रम अनुसार सम्पूर्ण विद्यार्थीहरूले प्रथम वर्षमा भूगर्भका core विषयहरू अध्ययन गर्ने छन्। दोस्रो वर्षमा तिनवटा छुट्टाछुट्टै विषयमा विशेषज्ञता हासिल गर्ने गरी पाठ्यक्रम निर्माण गरिएको छ। यसमा पनि applied geophysics, project management र research methodology जस्ता अत्यावश्यक विषयहरू सबै विद्यार्थीलाई अनिवार्य गरिएको छ। Research methodology विषयमा विद्यार्थीले applied statistics र computer application विषय पनि अध्ययन गर्नेछन्।

Engineering Geology समूहमा construction material engineering, tunneling, geological hazard and risk analysis जस्ता नया विषय प्रथम पटक समावेश गरिएको छ। Exploration and Mining Geology समूहमा geological and tunnel mapping का पाठ्यक्रम प्रथम पटक समावेश गरिएको छ। यसअघिका पाठ्यक्रममा Petroleum Geology ऐच्छिक रहेकोमा अहिले अनिवार्य गरिएको छ। Hydrogeology समूहमा water resource and watershed management विषय समावेश गरिएको छ। परिमार्जित पाठ्यक्रम अनुसार अध्ययन गरि निस्केका जनशक्तिले हाल देशमा आवश्यक दक्ष जनशक्तिको मागलाई सम्बोधन गर्ने कुरामा हामी विश्वस्त छौं।

तालिका ३: स्नातकोत्तर तह प्रथम वर्षको परिमार्जित पाठ्क्रम (२०६९)।

Course Title	Full Mark	Theory	Practical
Igneous and metamorphic Petrology	100	70	30
Sedimentology, and Mineralogy and Geochemistry	100	70	30
Structural Geology and Tectonics, and Photogeology, Remote Sensing and GIS	100	70	30
Paleontology and Introduction to Hydrogeology	100	70	30
Geomorphology and Himalayan Geology	50	50	-
Fieldwork	50		
Total	500		

तालिका ४: स्नातकोत्तर तह दितिय वर्षको, Engineering Geology विषयको परिमार्जित पाठ्क्रम (२०६९)।

Course Title	Full Mark	Theory	Practical
Applied Geophysics	50	35	15
Project Management and Research Methodology	50	35	15
Construction Material Engineering	50	35	15
Rock Mechanics and Tunnelling, and Soil Mechanics	100	70	30
Engineering Geological Site Investigation, and Geological Hazard and Risk Analysis	100	70	30
Fieldwork	50		
Dissertation	100		
Total	500		

तालिका ५: स्नातकोत्तर तह दितिय वर्षको, Exploration and Mining Geology विषयको परिमार्जित पाठ्क्रम (२०६९)।

Course Title	Full Mark	Theory	Practical
Applied Geophysics	50	35	15
Project Management and Research Methodology	50	35	15
Geology of Mineral Deposits	50	35	15
Exploration and Prospection Geology, and Geological and Tunnel Mapping	100	70	30
Mining Geology, and Petroleum Geology and Mineral Economics	100	70	30
Fieldwork	50		
Dissertation	100		
Total	500		

तालिका ६: स्नातकोत्तर तह दितिय वर्षको, Hydrogeology विषयको परिमार्जित पाठ्क्रम (२०६९)।

Course Title	Full Mark	Theory	Practical
Applied Geophysics	50	35	15
Project Management and Research Methodology	50	35	15
Water Resources and Watershed Management	50	35	15
Engineering Hydrology	100	70	30
Hydrogeology	100	70	30
Fieldwork	50		
Dissertation	100		
Total	500		

संस्थागत अन्तरसम्बन्ध र अन्तरक्रिया बढाउने

सरकारी, निकाय, उद्योग, शैक्षिक संस्था र स्वतन्त्र विशेषज्ञहरू एक अर्काका परिपूरक हुन् भन्ने कुरालाई हामीले आत्मसात् गर्न सकेको पाइँदैन। तसर्थ उद्योगले शैक्षिक संस्थालाई अध्ययन अनुसन्धानमा आर्थिक टेवा पुऱ्याउनु पर्दछ। शैक्षिक संस्थाहरूले उद्योग तथा सरकारी निकायमा अनुभव प्राप्त व्यक्ति तथा स्वतन्त्र विशेषज्ञलाई पढाउन आमन्त्रित गर्ने तथा उद्योगको आवश्यकता बमोजिमको जनशक्ति तयार गर्न जोड दिनु पर्दछ। भूगर्भशास्त्र केन्द्रीय विभागले यसतर्फ पहल गरिसकेको छ र यसै वर्षदेखि स्नातकोत्तर तह दोस्रो वर्षका विद्यार्थीहरूलाई विशेषज्ञहरू आमन्त्रण गरी guest lecture कक्षा सञ्चालन गर्न लागिएको छ। यस कार्यलाई निरन्तरता दिनु आवश्यक छ। यसबाट विशेषज्ञहरूले आफूले सिकेको सिप र ज्ञान युवा पुस्तालाई हस्तान्तरण गर्ने मौका मिल्ने छ भने विद्यार्थीहरूले पुस्तकमा लेखिएको वाहेक फिल्डमा काम गर्दा के कस्ता भौगर्भिक समस्याहरू आइपर्दछन् र तिनको समाधान कसरी गर्ने भन्ने ज्ञान हासिल गर्ने मौका मिल्दछ।

स्नातकोत्तर तहको विस्तार

त्रिभुवन विश्वविद्यालयमा egnigeering geology विषयको स्नातकोत्तर तहको छुट्टै उपाधी स्थापना को लागि गृहकार्य भैरहेको छ। भूगर्भशास्त्र केन्द्रीय विभाग र विषय समितिका बहुमत सदस्यहरूको धारणा भने तत्काल स्नातकोत्तर तहको छुट्टै उपाधी स्थापना गर्नुभन्दा स्नातक तहका कक्षा अन्य कलेजहरूमा विस्तार गरी स्नातकोत्तर तहमा भर्ना हुने विद्यार्थी सङ्ख्या बढेपछि मात्र अन्य विषयमा पनि उपाधि स्थापना गर्न उपयुक्त हुन्छ भन्ने रहेको छ। अहिले कम्तिमा २ ठाउँमा स्नातक तह सञ्चालन हुन थालेको र त्रि–चन्द्र कलेजमा पनि विद्यार्थीको सङ्ख्या बढिरहेको अवस्थामा भूगर्भ विषयको स्नातकोत्तर तह पनि विस्तारमा लाग्ने कुरालाई सकारात्मक रूपमा अघि बढाउनु पर्दछ। विद्यार्थी सङ्ख्या अत्याधिक बढेमा भूगर्भशास्त्र केन्द्रीय विभागले मात्र स्नातकोत्तर तह थाम्न सक्दैन र यस अवस्थामा M.Sc. Geloogy अन्य कलेजहरूमा पनि विस्तार गर्नु पर्नेहुन्छ। यस बारेमा हामीले समयमै सोच्नु जरूरी छ। हामीहरू नकारात्मक प्रतिस्पर्धा होइन एक अर्काका सहयोगी र निर्माणमुखी भएर काम गरियो भने मात्र भूगर्भशास्त्र विषय फस्टाउने छ र देशविकासमा यसले सकारात्मक सहयोग गर्ने छ।

निष्कर्ष

नेपालमा हाल भूगर्भशास्त्र विषय शिक्षाको अवस्था विद्यालय तहमा कमजोर अवस्थामा रहेको छ भने विश्वविद्यालय तहमा समेत सन्तोषजनक अवस्थामा रहेको छैन। विद्यालय तहमा पाठ्यक्रम अति न्यून छ र भएका पाठ्यक्रम पनि त्रुटीपूर्ण छन्। विश्वविद्यालय तहमा हालसम्म पनि एक ठाउँमा मात्र भूगर्भशास्त्र विषयको अध्यापन भइरहेको छ यसकारण स्नातकोत्तर तहमा भर्ना हुने विद्यार्थीको सङ्ख्या पनि भर्ना क्षमता भन्दा सधैं कम रहेको छ। यसले गर्दा एकातिर विद्यार्थी प्रतिस्पर्धी हुन सकेका छैनन् भने अर्कोतिर बजारमा माग अनुसारको जनशक्ति उत्पादन हुन सकेको छैन। यस अवस्थाको अन्त्य गर्न विद्यालय स्तरमा छिट्टै पाठ्यक्रम परिमार्जन गरी भूगर्भशास्त्र विषयको अङ्कभार बढाउनु पर्ने देखिन्छ भने स्नातक तहको पढाइ अन्य क्याम्पसहरूमा पनि विस्तार गर्नु पर्दछ। त्यसैगरी स्नातकोत्तर तहको पाठ्यक्रमलाई परिमार्जन गरी बजारको माग अनुरूपको जनशक्ति उत्पादन तर्फ लाग्नु पर्दछ।

सन्दर्भ सामग्रीहरू

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नेपालमा पाइएका बहुमूल्य टुरमलिन र भौगर्भिक अनुसन्धानमा यसको महत्व

सन्तमान राई

भूगर्भशास्त्र विभाग, त्रिचन्द्र बहुमुखी क्याम्पस

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सारांश

नेपालमा पाइएका Gem quality को टुरमलिन संखुवासभा जिल्लाको हृयाकुले, फाकुवा, चोकटे गाउँ, नुमु गाउँ र रानीढुङ्गा डाडाँगाउँको थर्बु क्षेत्र, रसुवा जिल्लाको लाङटाङ क्षेत्र, जाजरकोट जिल्लाको टीकाचौर, गर्खाकोट र लेखपाटन, मनाङ्गको नाजे गाउँ र ताप्लेजुङ्ग जिल्लाको इखाबु र फाबुङ्ग गाउँमा पाइएका छन् । यी बहुमूल्य टुरमलिनहरु प्राय जसो Pegmatite चट्टानमा पाइएका छन् । नेपालको मध्य क्षेत्रमा पाइएका टुरमलिनको अनुसन्धानबाट हिमालय बन्ने क्रममा Lesser Himalaya बाट Boron, H, O, Fl, CO_2, आदि टुरमलिन बन्ने रसायनिक तत्वहरु Higher Himalaya तिर संवाहन भएको पाइन्छ । फलस्वरुप Higher Himalaya तथा Tethys Himalaya को Granite तथा Pegmatite बन्ने क्रममा टुरमलिन खनिज पनि एक मुख्य खनिज बन्न पुगे । यसरी Granite तथा Pegmatite मा बहुमूल्य वा साधारण टुरमलिनको जन्म भएको देखिन्छ । परिवर्तित चट्टानमा पाइएका टुरमलिनको अनुसन्धानबाट तापक्रम र दवाबको वृद्धिसगै पहिल्यै बनेका टुरमलिन (Detrital tournaline) को रसायनिक बनावटमा फरक भई नयाँ किसिमको टुरमलिनको उत्पत्ति भएको पाइन्छ । सारांशमा भन्नु पर्दा हिमालय बन्ने क्रममा Fluids (Boron, H, O, F, Cl) को सवांहन भएको देखिन्छ ।

परिचय

बहुमूल्य रत्न (Gemstone or Precious stone) सम्बन्धी चासो राख्नु हुने महानुभावहरुलाई टुरमलिन (Tourmaline) रत्न वा खनिजको नाम नौलो होइन । यो बहुमूल्य रत्न विश्वको रोमन साम्राज्य (27 B.C.- 395 A.D.) समयदेखि नै सजावट (Decoration) ढुङ्गाको रुपमा प्रयोग भएको पाइन्छ । समयको अन्तरालपछि विभिन्न रङ भएको कारण बहुमूल्य रत्नको रुपमा चर्चामा आउन थाल्यो ।

सन् १९६२ मा एड्रियन नाम गरेका व्यक्तिले टुरमलिन रत्नको प्रयोगलाई चार किसिमले वर्णन गरेका छन् : (क) टुरमलिन गहनाको रुपमा लगाउने र महिलाले पुरुषलाई सजिलै आर्कषण गर्ने, (ख) मित्रता बढाउने, (ग) शुद्ध मन र स्वस्थ बनाउने (घ) कल्पना गर्नसक्ने क्षमतावान बनाउने । अमेरिकन जेम सोसाइटी (American Gem Society) ले टुरमलिन गहनाको रुपमा प्रयोग गर्नाले आत्म आनन्दमय हुन्छ भनी प्रकाशन गरेको समेत पाइयो । यी विभिन्न दर्शनहरु उल्लेख भएता पनि त्यो प्रयोग गर्ने व्यक्तिले नै विश्लेषण गर्न सजिलो पर्ला । तथापि यो एक बहुमूल्य रत्न हो भन्ने कुरामा भने कोही पनि दुई मत राख्न सक्दैनन् ।

रत्न (Gem) टुरमलिन पारदर्शी, बहुरङ्गी भएको, मणिभ (क्रिष्टल) आकृतिभएको, चिरा नभएको र विशेषगरी जुहारत व्यापारमा प्रयोग गर्ने रत्न भन्ने बुझ्नु पर्दछ । यस किसिमको टुरमलिनलाई मूल्यवान रत्न टुरमलिन (Precious tourmaline) भनिन्छ । कालो रङ्ग, पारदर्शी नभएको, चिराहरु भएको टुरमलिनलाई साधारण टुरमलिन (Common tourmaline) भनिन्छ । टुरमलिन एक बोरोन (Boron) तत्व भएको सिलिकेट्स (Boron Silicates) खनिज हो जसको ज्यामितीय स्वरुप रोम्ब (Rhomb) आकृति हुन्छ ।

टुरमलिनको रासायनिक बनावट र यसको किसिम

टुरमलिन विभिन्न रासायनिक तत्वहरु मिलेर बनेका हुन्छ । यस खनिजमा मुख्यगरी सोडियम (Na), क्यालसियम (Ca), फलाम (Fe), म्याग्नेसियम (Mg), अल्मुनियम (Al), लिथियम (Li), म्याग्नेज (Mn), बोरोन (B), सिलिका (Si), अक्सिजन (O), हाईड्रोजन (H), फ्लोरिन (F), भ्याग्नेडियम (V), क्रोमियम (Cr) आदि तत्वहरु पाइन्छन् । विभिन्न किसिमका टुरमलिनमा विभिन्न किसिमका तत्वहरुको समिश्रण हुन्छ । विभिन्न किसिमका टुरमलिनलाई विभाजन गर्न सजिलो होस् भन्नाका लागि विभिन्न तत्वहरुलाई $XY_3Z_6B_3Si_6O_{27}(O,OH,F)_4$ मा छुट्याउने गरिन्छ र X अन्तर्गत Na र Ca; Y_3 अन्तर्गत Fe^{2+}, Mg^{2+}, $Al \pm Li$, Mn र Z_6 अन्तर्गत Al^{3+}, Cr^{3+}, Mg^{2+}, V^{3+} राखिन्छ । सन् १९८५ मा Dietrich भन्ने वैज्ञानिकले टुरमलिनलाई रसायनिक तत्वको आधारमा विभिन्न किसिमको टुरमलिनका नामाकरण गरेका छन् (Table 1): Dravite नाम गरेको टुरमलिनमा Na, Mg, Al, B, Si, O, H र F तत्वहरुको समिश्रण पाइन्छ र यसको रासायनिक सूत्र $NaMg_3\ Al_6B_3Si_6O_{27}\ [O,OH]_3$ [OH, F] हो । त्यसै गरी अन्य टुरमलिनमा पनि विभिन्न तत्वहरुको समिश्रण हुन्छन् ।

टुरमलिनलाई चिन्ने आधार

टुरमलिनलाई विभिन्न किसिमले अध्ययन गरी चिन्न (Identification) सकिन्छ । यसको भौतिक गुण, रसायनिक गुण, सुक्ष्मदर्शक यन्त्रमा हेर्दा पाइने Optical गुण, चुम्बकीय गुण, विद्युतीय गुण तथा किरण छिर्दा देखिने गुण (Radioactivity) को आधारमा सजिलै चिन्न सकिन्छ । यी विभिन्न गुणहरुमध्ये यहाँ भौतिक गुणहरुमात्र चर्चा गरिन्छ किनकी हामीले यी गुणहरुलाई सजिलै अध्ययन गर्न सक्दछौं ।

Table 1: टुरमलिनको प्रकार (Dietrich 1985)

टुरमलिनको प्रकार	X	Y	Z	
Buergerite	Na	Fe_3^{3+}	Al_6	$B_3Si_6O_{27}(O,OH)_3(OH,F)$
Chromdravite	Na	Mg_3	$Cr_5\,Fe^{3+}$	$B_3Si_6O_{27}(O,OH)_3(OH,F)$
Dravite	Na	Mg_3	Al_6	$B_3Si_6O_{27}(O,OH)_3(OH,F)$
Elbaite	Na	$(Al, Li)_3$	Al_6	$B_3Si_6O_{27}(O,OH)_3(OH,F)$
Ferridravite	Na	Mg_3	Fe_6^{3+}	$B_3Si_6O_{27}(O,OH)_3(OH,F)$
Liddicoatite	Ca	$(Li, Al)_3$	Al_6	$B_3Si_6O_{27}(O,OH)_3(OH,F)$
Schorl	Na	Fe_3^{2+}	Al_6	$B_3Si_6O_{27}(O,OH)_3(OH,F)$
Uvite	Ca	Mg_3	$Al_5\,Mg$	$B_3Si_6O_{27}(O,OH)_3(OH,F)$

क) **मणिक आकृति (Crystal Shape):** Rhomb (Trigonal), समपार्श्व (Prismatic), लाम्चो (Tabular), पिरामिड ।

ख) **घनत्व (Density)**: Buergerite-3.305; Ferridravite-3.26; Liddicoatite-3.02; Schorl–3.13; Uvite–3.04 ।

ग) **रङ (Color)**: Buergerite- खैरो, Chromdravite - गाढा हरियो; Dravite साधारणतया खैरो, रातो, पहेंलो, हरियो, निलो, रङविहिन, सेतो, कालो; Elbaite- साधारणतया गुलाफी र हरियो, रङविहिन, रातो, सुन्तला रङ, पहेंलो, निलो, बैजनी रङ, सेतो, कालो खैरो; Ferridravite - कालो; Liddicoatite - Elbaite को जस्तै रङ; Schorl साधारणतया कालो, पहेंलो, हरियो, खैरो; Uvite - Dravite को जस्तै रङ भएको । रातो वा गुलाफी रङको टुरमलिनलाई Rubellite, हरियो रङकोलाई Verdelite र निलो रङको tourmaline लाई Indicolite टुरमलिन भनी नामाकरण पनि गरिन्छ ।

घ) **कडापन (Hardness)**: 7-7.5

टुरमलिन पाइने चट्टानहरु

यो खनिज तीन किसिमका (आग्नेय, पत्रे र परिवर्तित) चट्टानहरुमा पाइन्छ। Schorl tourmaline विशेषगरी आग्नेय चट्टानहरुमा पाइन्छ । टुरमलिन पाईने आग्नेय चट्टानहरु हुन् :- Granite, alaskite, charnockite, aplite, pegmatite, quartz diorite, quartz monzodiorite, diorite, gabbro, diabase, peridotite, kimberlite, rhyolite, pyroclasitic rocks । पत्रे चट्टानहरु जस्तै :- Conglomerate, gritstone, sandstone, shale, clastic limestone, evaporite हरुमा प्रायजसो Detrital tourmaline का रुपमा पाइन्छ । त्यसैगरी Residual soil, weathering crust, laterite bauxite मा पनि हुन सक्छन् । Aeolian sands, glacial deposit, delta आदि sediments मा पनि यो पाइन्छ । त्यसै गरी परिवर्तित चट्टानहरु : Gneiss, slate, phyllite, schist, marble, amphibolite, quartzite, eclogite, granulite, serpentinite, migmatite, tourmalinite आदिमा पनि टुरमलिन रहेको हुन्छ ।

नेपालमा पाइएका बहुमूल्य टुरमलिन

नेपालको खनिज सम्पदा एक विश्लेषणात्मक अध्ययन पुस्तकमा नेपालको खनिज बारे विस्तृत उल्लेख भएको पाइनछ (पौडेल २०६८) । त्यसै गरी नेपालमा पाइएको Gemstones को बारे नेपाल भौगर्भिक समाजले प्रकाशन गरेको बुलेटिनमा पनि विस्तृत जानकारी गरिएको छ (Kaphle 2011) । नेपालमा पाइने बहुमूल्य रत्नहरुको छोटो जानकारी अन्तुडाँडा द्वैमासिक पत्रिकामा प्रकाशित भएको छ (Rai 2068) । नेपालको विभिन्न किसिमका चट्टानहरुमा विभिन्न किसिमका टुरमलिनहरु पाइएता पनि बहुमूल्य किसिमका टुरमलिनको मात्रा भने ज्यादै नयून छ । नेपालमा पाइएका अधिकांश टुरमलिन कालो रङ, पारदर्शी नभएकोले यसको महत्व छैन भने पनि फरक पर्दैन । तथापि थोरै भएता पनि Gem quality को टुरमलिन नभएको भने चाहिँ होइन । तर यसको मात्रा कम हुनु वा अनुसन्धानको कार्य पर्याप्त नभएकोले यस खनिजको निश्चित परिमाण बारे यकिन गर्न सकिएको छैन ।

हालसम्म गरिएको अध्ययन, अनुसन्धानबाट नेपालको संखुवासभा जिल्लाको ह्याकुले र फाकुवा क्षेत्रमा पाइएको गुलाफी र हरियो रंगको Elbaite टुरमलिन नेपालमा ज्यादै प्रख्यात र बहुमूल्य पनि छन् । त्यस क्षेत्रमा Pegmatite चट्टानमा पाइएको टुरमलिनको उत्खनन् राणाकालमा नै भएको अभिलेखमा पाइन्छ । त्यसैगरी यसै जिल्लाको रानीढुङ्गा डाँडागाउँको थुर्बु Pegmatite र नूम गाउँको पूर्वीभाग माइसीमामा पनि Gem quality को टुरमलिन पाइएको उल्लेख छ । गाढा - निलो किसिमको Indicolite टुरमलिन यसै जिल्लाको ह्याकुले - फाकुवाबाट १६ कि.मी. पूर्व चोकटे भन्ने ठाउँमा पाइएको छ । गुलाफी रंगको

टुरमलिन रसुवा जिल्लाको लाङटाङ क्षेत्रमा पाइएको छ । पश्चिम नेपालको जाजरकोट जिल्लाको टीकाचौर, गरखाकोट र लेखापाटन गाउँमा पारदर्शी, पहँलो तथा सुन्तला रङको Uvite नामको टुरमलिन पाइएको छ । पूर्वी नेपालको ताप्लेजुङ जिल्लाको फाबुङ र इखाबु गाउँमा खैरो रङको टुरमलिन पाइएको उललेख छ । मनाङ्ग जिल्लाको नाजे गाउँमा पनि बहुमूल्य टुरमलिन पाइएको छ । नेपालका अन्य भू- भागहरुमा पनि यस किसिमको बहुमूल्य खनिज हुन सक्दछ ।

नेपालमा भौगर्भिक अनुसन्धानमा टुरमलिनको महत्व

टुरमलिनलाई यसको रसायनिक तत्वहरुको बनावटको आधारमा विभिन्न नाममा वर्गीकरण गर्न सकिन्छ । टुरमलिनको यी तत्वहरुलाई त्रिकोणीय चित्र : Schorlite (Fe) - Dravite (Mg) - Elbite (Al) (Henry and Guidotti 1985) मा राखेपछि कुन किसिमको टुरमलिन भनी यकिन गर्न सकिन्छ ।

आग्नेय चट्टान *(Granite, Pegmatite, Aplite - pegmatite)* मा पाइएका टुरमलिन

Fe को मात्रा बढी भएको टुरमलिन (Schorlite) प्रायजसो Granite मा पाइएको छ । यस खनिज बन्ने क्रममा Mg को मात्रा बढी भएको टुरमलिन (Dravite) बढी तापक्रममा बनेको पाइन्छ । जब तापक्रम क्रमशः घट्दै जान्छ, Fe को मात्रा बढी भएको टुरमलिन (Schorlite) क्रमशः विकास भएको देखिन्छ (Rai 2004)। नेपालको मध्यमाञ्चल क्षेत्र, विशेषगरी काठमाडौ-लाङटाङदेखि पोखरा-अन्नपूर्ण क्षेत्रसम्म गरिएको वैज्ञानिक अध्ययन, अनुसन्धानमा Higher Himalaya मा भएको Aplite - pegmatite dykes मा पाइएको टुरमलिनको रसायनिक बनोट अनुसार Mg को मात्रा बढी भएको टुरमलिन (Dravite) पाइन्छ भने Tethys Himalaya को Aplite-pegmatite dykes मा Fe (schorlite) र Al (Elbite) बढी भएको टुरमलिन पाइएको छ । यसरी Higher Himalaya (तल) देखि Tethys Himalaya (माथि) सम्म भएको Aplite - pegmatite dykes मा Mg को मात्रा क्रमशः घट्दै गई Fe र Al को मात्रा बढेको देखिन्छ । यसरी रसायनिक बनावटमा फरक देखिनुमा Magma को Fluid phase का रसायनिक बनावट र तापक्रमको परिवर्तनमा निर्भर रहेको देखिन्छ ।

Gem quality को टुरमलिन प्रायः गरी Pegmatite चट्टानमा पाइएका छन् । Pegmatite प्रायः गरी ठूलाठूला आग्नेय चट्टानको वरीपरि बनेका हुन्छन् । यी दुवै चट्टानहरु म्याग्मा चिसो भएर (Crystallization) बनेका हुन्छन् । तर Pegmatite चट्टान Granite बनेपछि मात्र बन्ने वा कुनै ठाउँमा म्याग्माको उत्पति भएपछि यो बिस्तारै चट्टानहरुको चिराहरुमा पसी चिसो भएको चट्टानको रुप लिन्छ । यसरी Granite वा Pegmatite बन्ने म्याग्मामा विशेषगरी बोरन (B), फ्लोरीन (F), पानी (H_2O) रहने भएकोले टुरमलिन बन्ने संरचना तयार हुन्छ (Pichavant 1981) । Higher Himalaya वा Tethys Himalaya मा पाइएका आग्नेय चट्टान Granite मा Boron तत्वको मात्रा ९५० ppm सम्म भएकोले त्यस चट्टानमा Tourmaline बन्नु उपयुक्त मानिन्छ (Rai 1993, Rai and Le Fort 1993) । यसै गरी Pegmatite चट्टानमा पनि प्रशस्त Tourmaline बन्नुको कारण पनि Pegmatite मा Boron को मात्रा बढी हुनु हो । Granite वा Pegmatite मा प्रशस्त Tourmaline बन्नुमा Higher Himalaya को चट्टानहरु Lesser Himalaya माथि Overthrusting (चढेर जादाँ) Lesser Himalaya को Boron तत्व Higher Himalaya मा प्रवेश गर्दछन् । यो प्रवेश गर्ने क्रम Main Central Thrust को गति भएको बेलामा हुन्छन् । यसरी Main Central Thrust गतिशिल हुने क्रममा Lesser Himalaya बाट Boron, F, वा H_2O आदि Higher Himalaya मा प्रवेश गर्ने, उच्च तापक्रम र दवाब पैदा हुने कारणले Higher Himalaya को तलको भूभाग आंशिक रुपमा पग्लन गई म्याग्माको उत्पत्ति हुन जान्छ र यी म्याग्माबाट टुरमलिन भएको Granite वा Pegmatite वा Aplite चट्टान बन्दछन् (Rai 2004)। ह्याकुलो र फाकुवा यस्तै प्रक्रियाबाट बनेका Pegmatite हुन् जहाँ बहुमूल्य टुरमलिन पाइएको छ । हिमालयको उत्पतिको क्रममा Fluids (Boron, CO_2, H_2O, Cl, F) कसरी सम्बाहन (Circulation) भयो भन्ने भौगर्भिक अध्ययनको लागि यो खनिजको अध्ययन ज्यादै महत्वपूर्ण मानिन्छ । यी Fluids ले granite बन्नुमा के भूमिका निभायो भन्ने चर्चा गर्नुपर्दछ ।

परिवर्तित चट्टानमा पाइएका टुरमलिन

नेपालको मध्यमाञ्चल क्षेत्र, विशेषगरी काठमाडौ-लाङटाङदेखि पोखरा-अन्नपूर्ण क्षेत्रसम्म गरिएको वैज्ञानिक अध्ययनमा रसायनिक तत्वको आधारमा Ca मात्रा बढी भएको परिवर्तित चट्टानहरु जस्तै Gneiss (Calcic-gneiss) वा marble मा Mg मात्रा बढी बढी भएको Dravite किसिमको टुरमलिन पाइएको देखिन्छ । Fe र Mg करीब बराबर भएको टुरमलिन granitic gneiss, pelitic gneiss, schist, migmatite, quartize चट्टानहरुमा भएको पाइन्छ (Rai and Le Fort 2002) । Lesser Himalaya को परिवर्तित चट्टानहरुमा पाइएको टुरमलिनको अध्ययनबाट ताप र दबाबको प्रभावको कारणले टुरमलिनको रसायनिक बनावटमा पनि फरक ल्याएको देखिन्छ । Lesser Himalaya को तल्लो भागबाट माथिल्लो भागमा क्रमशः तापक्रम र दवाब बढ्दै जान्छ, यस अवस्थामा टुरमलिनमा भएको Mg को मात्रा बढेर जाने र Fe र Al को मात्रा क्रमशः घटेर जाने रसायनिक प्रक्रिया देखिन्छ (Rai and Le Fort 2002) । त्यसै गरी Higher Himalaya मा भने तलको बनावट देखि माथि जाँदा Fe को मात्रा बढ्ने र Mg र Al को मात्रा घटेको पाइन्छ । अर्थात तापक्रम र दबाब घटबढ हुँदा एक तत्वले अर्को तत्वलाई विस्थापित गर्दछ ।

निष्कर्ष

नेपालको परिप्रेक्ष्यमा भन्नुपर्दा बहुमूल्य टुरमलिनको अंश ज्यादै कम छ, तथापि हिमालयको भौगर्भिक अनुसन्धानको क्रममा लिने हो भने जुनसुकै

किसिमको टुरमलिनको विशेष महत्व हुन्छ। हिमालय बन्ने क्रममा बोरन, हाइड्रोजन, अक्सिजन, फ्लोरिन, क्याल्सियम आदिको कस्तो भूमिका रह्यो भन्नको लागि टुरमलिन खनिजलाई मुख्य अनुसन्धान गरिने भएको ले यसको महत्वलाई कम ठान्न मिल्दैन । नेपाल हिमालयको आग्नेय चट्टान (Granite, Pegmatite, Aplite) तथा परिवर्तित चट्टानहरुमा पाइएका टुरमलिनहरुको रसायनिक वनावटको आधारबाट हिमालय बन्ने क्रममा Fluids को सवांहन (Circulation) बाट नै टुरमलिन खनिजको उत्पत्ति भएको देखिन्छ ।

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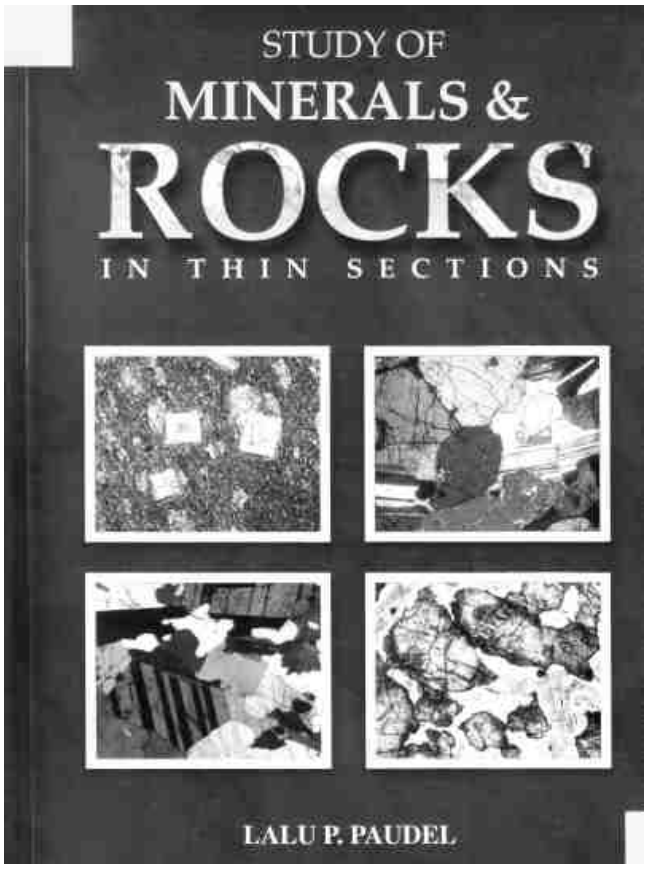
NEW BOOKS OF GEOLOGY PUBLISHED IN NEPAL



Study of Minerals and Rocks in Thin Sections

Authors: Lalu P. Paudel

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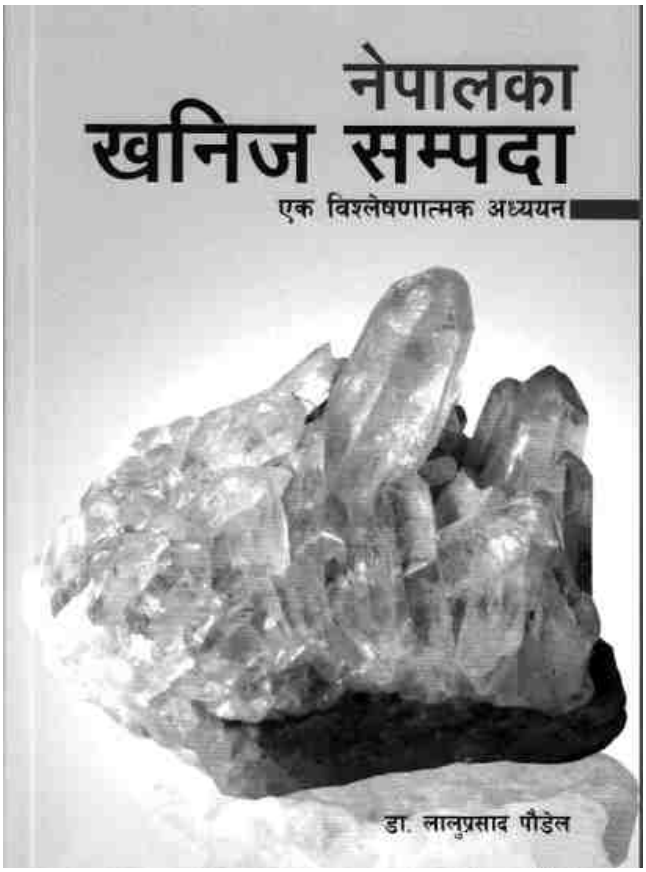
This book provides concise and straightforward laboratory techniques for identification of minerals and rocks in thin-sections. First three chapters of the book provide basic knowledge on the use of petrological microscope, methods of preparation of thin sections and optical properties of minerals. Remaining four chapters deal with the routine identification procedures of minerals, and igneous and metamorphic rocks. The book addresses the problems faced by graduate students during practical classes of mineralogy and petrology. The book describes optical properties of and identification method of five essential minerals needed for the identification and classification of igneous and metamorphic rocks. Colored photographs of the essential minerals have been given so that it can help in identification of the minerals.



नेपालका खनिज सम्पदा :एक विश्लेषणात्मक अध्ययन ।

लेखक: डा. लालुप्रसाद पौडेल, प्रकाशक: देबी दकाल

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संस्थागत मूल्य: रू. ४००, व्यक्तिगत मूल्य: रू. २००

नेपालमा आम नागरिकहरूमा खनिज सम्बन्धी चेतना अति न्यून भएको, पाठ्यक्रममा खनिज सम्बन्धी पाठ समावेश नगरिएको र नेपाली भाषामा भूगर्भ र खनिज सम्बन्धि पुस्तकहरूको अभाव भएको परिप्रेक्ष्यमा आम नागरिकलाई नेपालको भौगर्भिक अवस्था, खनिज सम्पदाको अवस्था, विकासका सम्भावना र समस्याका बारेमा ज्ञान होस् भन्ने हेतुले यो अनुसन्धानात्मक पुस्तक तयार गरिएको हो यस पुस्तकमा खानी खनिजका क्षेत्रमा केकस्ता कार्यकलापहरू भएका छन्, यस क्षेत्रको सदुपयोग नहुनुमा के कति कमजोरीहरू छन् र त्यस्ता कमी-कमजोरीहरूलाई हटाउन के कस्ता प्रयत्नहरू गर्नुपर्छ भन्ने विश्लेषण समेत पुस्तकमा गरिएको छ । यसका साथै नेपालका विभिन्न स्थानमा उपलब्ध खनिजहरूको अवस्थिति, तिनीहरूको उत्पति, मात्रा र विश्वबजारमा तिनीहरूको महत्त्वका बारेमा तथ्यहरू प्रस्तुत गरिएको छ । खनिजका बारेमा नेपाली भाषामा लेखिएको यो पहिलो अनुसन्धानात्मक कृति हो । यस कृतिको प्रकाशनबाट देशका नीतिनिर्माताहरू, प्राध्यापकहरू, खानीखनिजसम्बद्ध उद्यमीहरू, सरकारीसेवामा कार्यरत सम्बन्धित विज्ञहरू, विद्यार्थीहरू एवं जिज्ञासु पाठकहरू लाभान्वित हुने देखिन्छ ।

Study of Minerals and Rocks in Hand Specimens

Author: Santa Man Rai

Publisher: Tara Rai

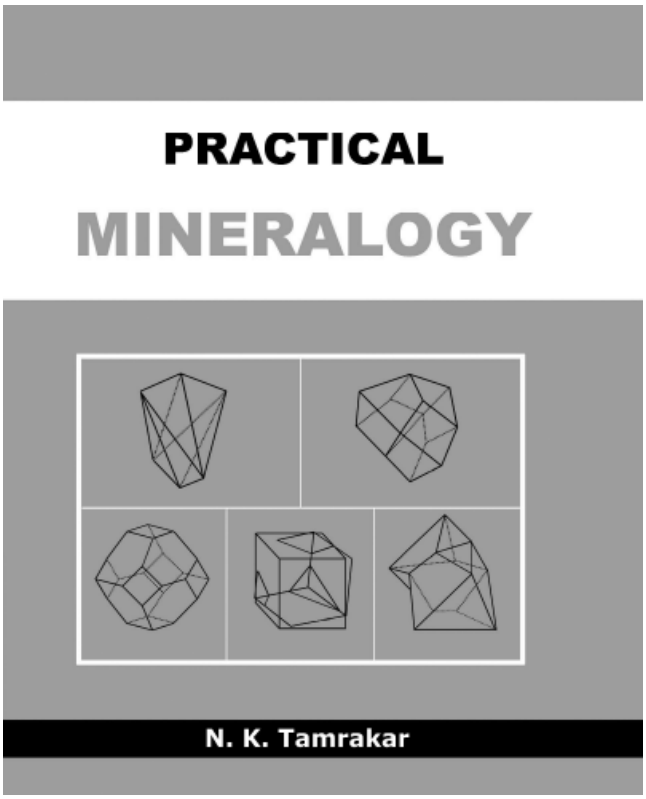
Number of Pages: 152

ISBN: 978-9937-2-4254-7

Year of Publication: 2011

Price: NRs. 250.00

The origin of crystals, minerals and rocks is an important indicator of the evolution of the dynamic planet Earth. The study of these materials can play a vital role in interpreting the geological history of the Earth. This introductory book has been designed as a lab manual for the Bachelor level students in Geology, Environmental Science and Civil Engineering with a view to helping them identifying different types of crystals, minerals and rocks in course of their practical classes. It offers the basic concepts and guidelines in a language and the topics have been included on the basis of syllabus prepared by Tribhuvan, Kathmandu, Pokhara and Purbanchal universities.



Practical Mineralogy

Author: Naresh Kazi Tamrakar

Publisher: Central Department of Geology, Tribhuvan University, Kathmandu, Nepal

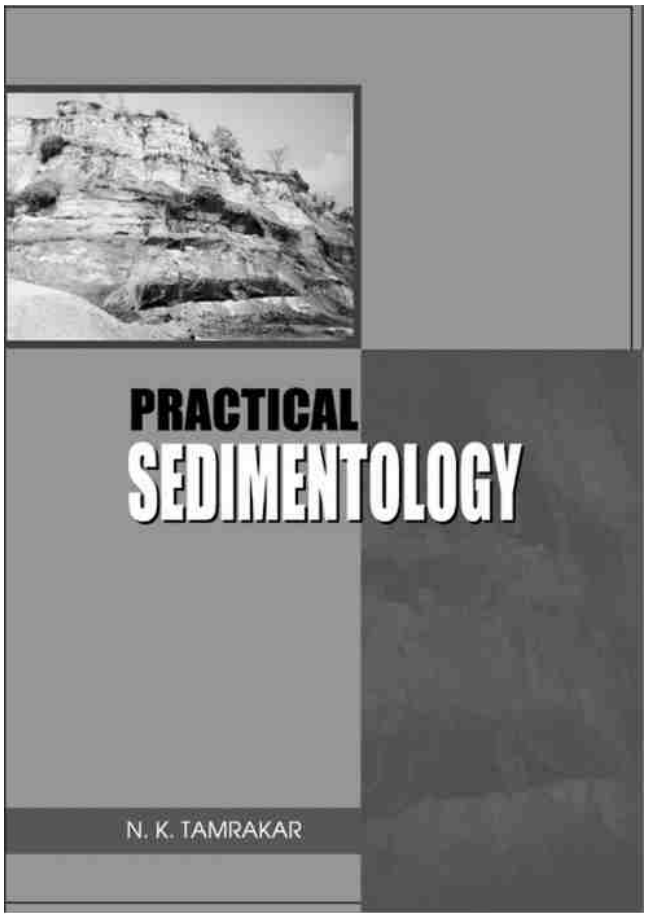
Number of Pages: 184

ISBN: 978-9937-524-30-8

Year of Publication: 2011

Price: NRs. 350/-

This practical manual has been designated to give student a practical input on how to treat crystals, and identify minerals in hand specimens and under a polarizing microscope. The objectives of this book are to provide instructions on identifying criteria for crystal symmetry elements, crystal morphology, crystal forms, system, and space lattices, and on studying properties and identifying minerals in hand specimens and under thin-sections. This book is useful particularly for the students of geology, and for the students of other disciplines who are taking part of the elementary courses of geology. There are seven chapters, the first three chapters deal with crystallography. Other chapter includes systematic mineralogy; physical properties of minerals and their identification in hand specimens; the optical properties of isoaxial, uniaxial and biaxial minerals under a polarizing microscope.



Practical Sedimentology

Author: Naresh Kazi Tamarkar

Publisher: Bhrikuti Academic Publication, Exhibition Road, Kathmandu, Nepal

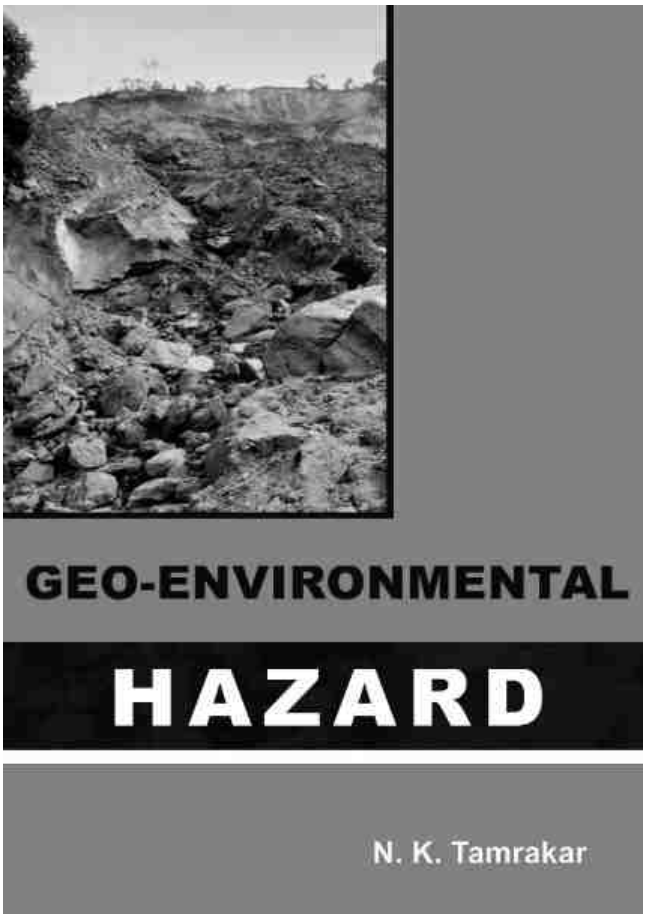
Number of Pages: 229

ISBN: 978-9937-234-43-6

Year of Publication: 2011

Price: NRs. 495/-

This book is intended to provide practical knowledge on working with various sedimentological problems, and serves for understanding procedures of lab analyses, data recording and field identification of texture, fabric, structure and composition of sediment and sedimentary rocks. There are ten chapters, of which first five chapters deal with texture, fabric, sedimentary structure and paleocurrent analysis. The chapters six, seven, eight and nine deal with mineral components, classification of sediments and sedimentary rocks, megascopic examination and microscopic examination of rocks, respectively. The chapter ten treats on facies analysis for interpretation of environmental models.



Geo-environmental Hazard

Author: Naresh Kazi Tamrakar

Publisher: Central Department of Geology, Tribhuvan University, Kathmandu, Nepal

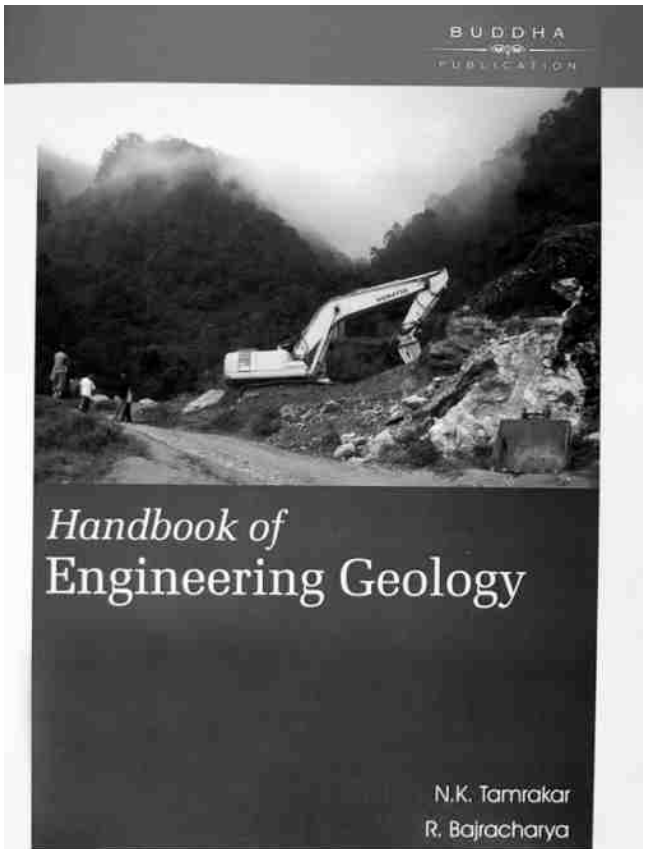
Number of Pages: 186

ISBN: 978-9937-524-41-4

Year of Publication: 2011

Price: NRs. 400/-

There are eleven chapters in this book. The first two chapters introduce distribution of hazards in Himalayas and concept of hazard and risk. Other chapters cover rocks and soils as geological materials; hydrology of natural hazards and elucidates on erosion problems; treatments on river morphology, dynamics and stream bank erosion hazard assessment and mitigation; flooding, flood hazard mapping, and management measures; glacial processes, potentially dangerous glacial lakes in Nepal, GLOF and their mitigation measures; landslide hazard, landslides in Nepal, hazard mapping and mitigation; earthquakes; bio-engineering methods for stabilizing hillslopes and riverbanks and coastal hazards.



Handbook of Engineering Geology

Authors: Naresh Kazi Tamrakar and Ramita Bajracharya

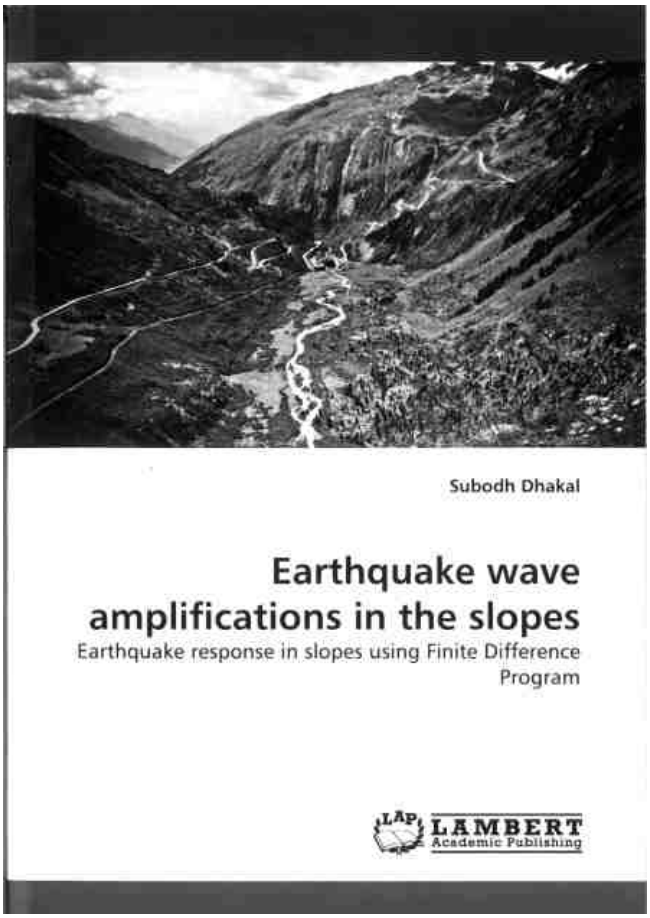
Publisher: Buddha Academic Enterprises Pvt. Ltd., Kathmandu, Nepal

ISBN: 978-9937-301-61-1

Year of Publication: 2011

Price: NRs. 365/-

This book will be helpful to undergraduate students of Civil Engineering and to undergraduate and graduate students of Geology and Environmental Science. This handbook is resolved into twelve chapters. The first three chapters deal with properties of minerals, soils and rocks, and various geological structures. Preparation and interpretation of geological cross-sections and geological maps; borehole problem; various elements of engineering geological maps, preparation of engineering geological maps and/or plans for landslides and road alignments are other topics covered in the book. Other chapters cover stereographic projections; kinematic analyses of discontinuity in rocks and slopes; weathering profiles; study of sand grains under a binocular microscope, and estimation of reserve of construction material by various methods; rock mass classification and rock mass rating for engineering purposes.



Earthquake wave amplifications in the slopes

Earthquake response in slopes using Finite Difference Program

Author: Subodh Dhakal

Publisher: LAP LAMBERT Academic Publishing, Germany

ISBN: 978-3-8433-7881-9

Year of Publication: 2010

Price: Euro 59.00

The purpose of this book is two fold: firstly, it provides some insight about the Finite Difference Program, FLAC and its application for the dynamic modeling in slopes; secondly and most importantly it provides the probable scale of slope amplification during earthquake in relation to the input wave frequency, slope geometry and geotechnical properties of the slope. This book consists of seven chapters that cover the theoretical aspects of the ground response analysis and the past research; important aspects of dynamic modeling methods; details of FLAC software; description and interpretation of the relationship between different input parameters and the output; data analysis and an empirical function of slope height, shear wave velocity and input frequency on amplification and recommendations for future research.

River degradation: Issues and Challenges
Author: Dr. Basanta Raj Adhikari
Publisher: LAP LAMBERT Academic Publishing, Germany
Number of Pages: 160
ISBN: 978-3-8484-3962-1
Year of Publication: 2011
Price: Euro 59.00

The book covers all the important aspects of river degradation mechanism and its impact on environment combining field observation and lab analysis. The book presents the sample study of Bishnumati River of Kathmandu valley, Nepal. Bank erosion, destruction of riparian vegetation and waste disposal within the river are described in detail. The river is going through degradation due to natural and human-induced disturbances. Excavation of sediment, channelization and damming, land-use changes, encroachment of river banks, clearing of riparian vegetation, discharge of effluents, pilling of manure, waste dumping and disposal are the causes of river environmental degradation. Mitigation measures like regular monitoring of river, management of waste and land-use, and bank stabilizing works should be implemented to improve river environment.

Geology for Civil Engineers
Author: Ananta Man Singh Pradhan
Publisher: LAP LAMBERT Academic Publishing
Number of Pages: 112
ISBN: 978-3847324089
Year of Publication: 2011
Price: Euro 38.19

This well-organized book provides a comprehensive treatment of geology for civil engineers. It gives the latest techniques and methodologies, and in particular, addresses the special requirements of knowledge of geology in the field of engineering. Structured primarily as a reference book to meet the requirement of civil engineering students for courses in geology, this book can also be of considerable value to students pursuing courses in agriculture, soil science, forestry and environmental science.

A practical approach to Environmental Geology

Author: Ananta Man Singh Pradhan

Publisher: LAP LAMBERT Academic Publishing

Number of Pages: 244

ISBN: 978-3847332824

Year of Publication: 2011

Price: Euro 66

This book is designed to meet the requirements of the Bachelor and Post Graduate students. The well organized book provides a comprehensive treatment of environmental geological problems. The key features of the book are: emphasis fundamentals and application of basic principles; focuses on detailed treatment of theory; presents the analysis and provides solved design problems and exercises to develop clear understanding of the theory.

Engineering and geotechnical investigation of Bungmati Landslide

Author: Ananta Man Singh Pradhan

Publisher: LAP LAMBERT Academic Publishing

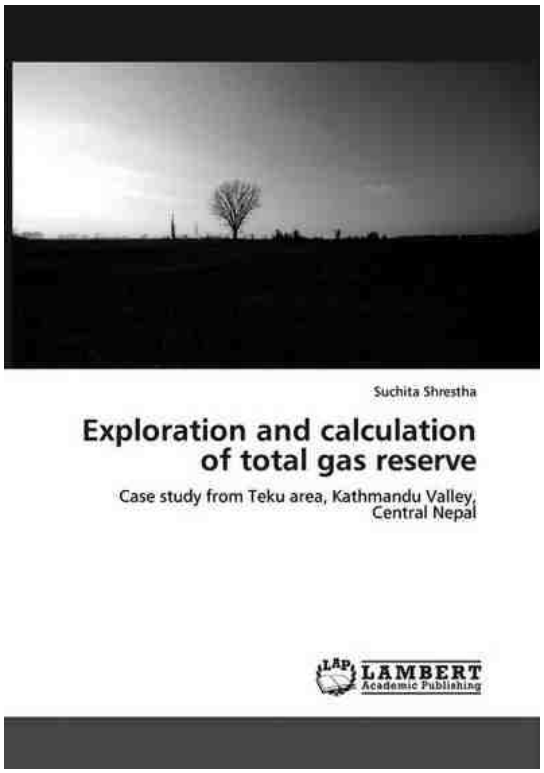
Number of Pages: 128

ISBN: 978-3845404813

Year of Publication: 2011

Price: Euro 59

The prime purpose of this book is to present the basic principles of slope stability analysis. The finite element method consists in dividing the particles into individual elements with sufficiently simple configuration. The advantage of a finite element approach in the analysis of slope stability problems over traditional limit equilibrium methods is that no assumption needs to be made in advance about the shape or location of the failure surface, slice side forces and their directions. The book is useful for the instructors and discerning students for a deeper study on the field of slope stability analysis. A short glance is presented on the geology and geotechnical parameters of Bungmati Landslide (soft soil landslide) of the Central Nepal.



Exploration and calculation of total gas reserve

Author: Suchita Shrestha

Publisher: LAP LAMBERT Academic Publishing

Number of Pages: 92

ISBN: 978-3845470825

Year of Publication: 2011

Price: Euro 70

The prime purpose of this book is to present the basic principles of exploration and calculation of reserve of natural gas deposit. A short glance is presented on the natural gas deposit in Teku, Kathmandu valley. The survey area covered of 4 sq.km, out of the valley's total area of 650 sq.km. 14 wells previously drilled in this area were used, having depth of about 300 m. It is found that people are willing to replace their existing source of energy.

All the members of Nepal Geological Society are

Codially requested to participate in the

27th Himalaya-Karakoram-Tibet (HKT) Workshop

to be organized by the

Nepal Geological Society

from

28 – 30 November 2012

Kathmandu, Nepal

RECENT JOURNALS AND BULLETINS OF GEOLOGY

Six issues of various journals and bulletins related to geology have been published by the Nepal Geological Society, Department of Mines and Geology, Central Department of Geology, TU and Department of Geology, Tri-Chandra Campus. They are as follows:

Journal of Nepal Geological Society, Vol. 43 (Special Issue), 2012.

Journal of Nepal Geological Society, Vol. 42, 2011.

Bulletin of Department of Geology, Tribhuvan University, Vol. 14, 2011.

Annual Report of Department of Mines and Geology, Vol. 8, 2012.

Journal of Stratigraphic Association of Nepal, Vol. 7, 2011.

GEOWORLD, 2012 Edition, Students Geological Society of of Department of Geology, Tri-Chandra Campus.

NEW MEMBERS OF THE NEPAL GEOLOGICAL SOCIETY

LM	Name	Address	Email
644	Mr. Prabhu Ram Silwal	Sinamangal, Kathmandu, Nepal	prabhulll@yahoo.com
645	Mr. Bishnu Shiwakoti	Synergy Power Development P. Ltd	bisnhu-shiwakoti@yahoo.com
646	Mr. Upendra Baral	Kapurdhara Marg, Ktm	upendrabaral@gmail.com
647	Mr. Pankaj Devkota	Gongbu-8, Kathmandu	pdevkota@msn.com
648	Mr. Nabin Osti	Dhawa-8, Gorkha	ostinabin@yahoo.com, ostinabin1@gmail.com
649	Dr. Kyle Larson	88/AVE CN, Saskawan, Saskatchewan, Canada	kyle.larson@usask.ca
650	Dr. Laurent Bollinger	DASE/France	laurent.bollinger@gmail.com
651	Mr. Shrawan Khanal	Dept. of Irrigation	shrawankhanal@hotmail.com
652	Mr. Umesh Chandra Bhusal	Urampokhara, Parbat	ucbhusal@gmail.com
653	Mr. Hari Ghimire	Parroha, Rupendehi	haringhimire@yahoo.com
654	Mr. Dilendra Raj Pathak	Mahendra Nagar, Nepal	satya2005@gmail.com
655	Dr. Janak Bahadur Chand	Bhim Datta Municipality-18, Kanchanpur	chand_jb@yahoo.com

OBITUARY

Late Dr. Augusto Gansser-Biaggi

(Oct. 28, 1910–Jan.9, 2012)

Augusto Gansser-Biaggi, a swiss geologist, was born in Milan, Italy on 28 October, 1910. He studied Geology at Zürich University where he earned geological degree in 1936. In the same year, he took part in the Swiss geological expedition to the Himalaya and Southern Tibet, including a geological excursion.

In 1958 Dr. Gansser obtained a Professorship, and he was appointed Head of the Geological Section of the Federal Institute of Technology and the Zurich University. During that period he carried out detailed explorations in various regions of Himalaya including Northern Pakistan, Ladakh, Nepal, Southern Tibet and Bhutan. The results of his researches were retained in a large number of publications. His book *Geology of the Himalaya* earned him the 'Patron's Medal of the Royal Geographical Society London'. Professor Gansser is a member of the National Academy of Sciences (USA), as well as the Academia Nazionale dei Lincei (Rome).

Nepal Geological Society honored **Dr Augusto Gansser-Biaggi** with the '**Honorary Membership of the Nepal Geological Society in 2005**' for his valuable contribution to scientific researches in the Nepal Himalaya.

Dr. Gansser died in Massagno TI, Switzerland on 9 January, 2012. Nepal Geological Society expresses heartfelt condolence on demise of Dr. Gansser. His contribution to the Himalayan Geology will always be remembered.

May his soul rest in perfect peace.

Raju Shrestha was born at Basundhara, V.D.C - 7, Dhapasi, Kathmandu on 30 August, 1978. He had obtained MA in Sociology and MSc in Geology from the Tribhuvan University. He worked as a part time lecturer at the Central Department of Geology after his graduation in 2002. Later on, he was working as a consultant geologist in different NGOs and INGOs mainly in the field of Arsenic contamination in groundwater. He was a very enthusiastic, hardworking and amicable person. He was the Life Member (LM-572) of the Nepal Geological Society. He died on 22 April, 2011 Kathmandu.

Nepal Geological Society expresses heartfelt condolence on demise of Mr. Shrestha.

May his soul rest in perfect peace.

Late Mr Raju Shrestha

Aug. 30, 1978–Apr. 22, 2011

CONGRATULATIONS

AWARD

The Nepal Geological Society extends its heartiest congratulation to **Mr. Madhav Raj Pandey** for receiving Science and Technology Award for 2067/2068 B.S. (2010/2011) for his outstanding contribution in establishing seismological data processing centre, its operation and integration of seismological results with geological and geophysical data for studying earthquake pattern in Nepal.

Science and Technology Award is the highest science and technology award established by NAST in 1986. It is conferred every two years to Nepali researchers who have made remarkable contributions in the field of science and technology.

PROMOTION

The Nepal Geological Society extends its heartiest congratulation to the following members of the Nepal Geological Society for their promotion.

Mr. Uttam Bol Shrestha (LM 224)

Promoted to Deputy Director General of the Department of Mines and Geology.

Date of Promotion: 2069/02/12.

Mr. Devi Nath Subedi (LM 42)

Promoted to Superintendent Geologist, Special Economic Zone, Ministry of Industry

Date of Promotion: 2068/11/04.

Mr. Rajendra Pd. Khanal (LM 351)

Promoted to Superintending Geologist (Project Chief) of the Petroleum Exploration Promotion Project in the Department of Mines and Geology.

Date of Promotion: 2068/11/4.

APPOINTMENT

The Nepal Geological Society extends its heartiest congratulation to the following members of the Nepal Geological Society for their appointment into an executive position.

Dr. Lalu Prasad Paudel (LM 301)

Appointed to Head, Central Department of Geology, Tribhuvan University

Date of Appointment: 2068/12/01.

Ph. D. AWARD

The Nepal Geological Society extends its heartiest congratulation to the following members of the Nepal Geological Society for obtaining Ph. D.

Dr. Damodar Lamsal (LM 573)

Institute: Hokkaido University, Sapporo, Hokkaido, Japan

Thesis Title: Studies on Glacier Lake Development in the Eastern Nepal Himalaya from 1964 to 2010.

Year of Ph.D. Award: 2011

Dr. Ramamohan Pokhrel (LM 554)

Institute: Graduate school of Science and Engineering, Saitama University, Japan.

Thesis Title: GIS approach for zoning spatial variation of liquefaction potential in sedimentary deposits

Year of Ph.D. Award: 2011

Dr. Ganesh Raj Joshi (LM 530)

Institute: University of the Ryukyus, Okinawa, Japan

Thesis Title: Present-day Stress Field, Crustal Deformation and Development of Extensional Tectonic Activities in the Compressional Setting of the NW-Himalaya and Southern Tibet: Insight from Numerical Simulation

Year of Ph.D. Award: 2010

Dr. Gyanendra Gurung (LM 557)

Institute: Chonbuk National University, Republic of Korea

Thesis Title: Theoretical Seismograms for 3-D Heterogeneous Models with Variable Surface Curvatures: Torsional Modes

Year of Ph.D. Award: 2012

Dr. Matrika Pd. Koirala (LM 521)

Institute: Department of Physics and Earth Science, University of the Ryukyus, Okinawa, Japan

Thesis Title: Numerical Simulation of stress field, implication and examples from strike slip zone and continental collision zone.

Year of Ph.D. Award: 2011

Dr. Jyotindra Sapkota (NA)

Institute: James Cook University, Townsville, Qld, Australia

Thesis Title: Structure, Metamorphism and Tectonics of the Central Nepal Himalayas

Year of Ph.D. Award: 2012

Dr. Janak Bdr. Chand (LM 665)

Institute: Department of Civil and Structural Engineering, Graduate School of Engineering, Kyushu University, Fukuoka, Japan

Thesis Title: Numerical Simulation of stress field, implication and examples from strike slip zone and continental collision zone.

Year of Ph.D. Award: 2011

NEW JOB ENTRY AS A GEOLOGIST

The Nepal Geological Society extends its heartiest congratulation to the following members of the Nepal Geological Society for their success in getting a permanent job in different government offices.

1. Mr. Anil Khatri, Hydrogeologist, Ministry of Irrigation(LM 637)

2. Mr. Kameswor Yadav, Hydrogeologist, Ministry of Irrigation(NA)

3. Mr. Narayan Krishna Ganesh, Engineering Geologist, Ministry of Irrigation (LM 635)

4. Dr. Matrika Pd. Koirala, Engineering Geologist, Department of Electricity Development, Ministry of Energy (LM 521).

LIST OF PUBLISHED JOURNALS OF NEPAL GEOLOGICAL SOCIETY

1. Journal of Nepal Geological Society, Vol. 43, 2012.
2. Journal of Nepal Geological Society, Vol. 42, 2012.
3. Journal of Nepal Geological Society (Abstract of Sixth Nepal Geological Congress on Geology, Natural Resources, Infrastructures, Climate Change and Natural Disasters, 15-17 November 2010), Vol. 41 (Special issue), November, 2010.
4. Journal of Nepal Geological Society, Vol. 40, June 2009.
5 . Journal of Nepal Geological Society, Vol. 39, June 2009.
6. Journal of Nepal Geological Society (Proceedings of International Workshop on Seismology Seismotectonics, and Seismic Hazard in Nepal Himalaya, 28–29 November 2006 and Fifth Nepal Geological Congress on Geology, Environment, and Natural Hazards Mitigation: Key to National Development, 26–27. November 2007), Vol. 38 (Special Issue), December 2008.
7. Journal of Nepal Geological Society, Vol. 37, June 2008.
8. Journal of Nepal Geological Society (Abstracts of Fifth Nepal Geological Congress on Geology, Environment, and Natural Hazards Mitigation: Key to National Development, 26–27 November 2007), Vol. 36 (Special Issue), November 2007.
9. Journal of Nepal Geological Society, Vol. 35, June 2007.
10. Journal of Nepal Geological Society (Proceedings of Fifth Asian Regional Conference on Engineering Geology for Major Infrastructure Development and Natural Hazards Mitigation, 28–30 September 2005), Vol. 34 (Special Issue), December 2006.
11. Journal of Nepal Geological Society, Vol. 33, June 2006
12. Journal of Nepal Geological Society (Abstracts of Fifth Asian Regional Conference on Engineering Geology for Major Infrastructure Development and Natural Hazards Mitigation, 28-30 September 2005), Vol. 32 (Special Issue), September 2005.
13. Journal of Nepal Geological Society, Vol. 31, June 2005.
14. Journal of Nepal Geological Society (Proceedings of Fourth Nepal Geological Congress, 9–15 . April 2004), Vol. 30 (Special Issue), December 2004.
15. Journal of Nepal Geological Society, Vol. 29, June 2004.
16. Journal of Nepal Geological Society, Vol. 28, June 2003.
17. Journal of Nepal Geological Society (Proceedings of Third Nepal Geological Congress, 26-28 September 2001, Kathmandu, Nepal), Vol. 27 (Special Issue), December 2002.
18. Journal of Nepal Geological Society, Vol. 26, June 2002
19. Journal of Nepal Geological Society (Proceedings of Workshop on the Himalayan Uplift and Palaeoclimatic Changes in Central Nepal, 10 November 2000), Vol. 25 (Special Issue), December 2001.
20. Journal of Nepal Geological Society (Abstract Volume of Third Nepal Geological Congress, 26–28 September 2001), Vol. 24 (Special Issue), September 2001.

21. Journal of Nepal Geological Society, Vol. 23, June 2001
22. Journal of Nepal Geological Society (Proceedings of International Symposium on Engineering Geology, Hydrogeology, and Natural Disaster with Emphasis on Asia, 28–30 September 1999, Kathmandu, Nepal), Vol. 22 (Special Issue), December 2000.
23. Journal of Nepal Geological Society, Vol. 21, June 2000
24. Journal of Nepal Geological Society (Abstract Volume of International Symposium on Engineering Geology, Hydrogeology, and Natural Disaster with Emphasis on Asia, 28–30 September 1999, Kathmandu, Nepal), Vol. 20 (Special Issue), 1999.
25 . Journal of Nepal Geological Society, Vol. 19, 1999
26. Journal of Nepal Geological Society (Proceedings of Second Nepal Geological Congress, 1995), Vol. 18 (Special Issue), 1998.
27. Journal of Nepal Geological Society, Vol. 17, 1997
28. Journal of Nepal Geological Society (Abstract Volume of Second Nepal Geological Congress), Vol. 16 (Special Issue), 1997.
29. Journal of Nepal Geological Society, Vol. 15, 1997
30. Journal of Nepal Geological Society (Proceedings of First Nepal Geological Congress, 1995), Vol. 14 (Special Issue), 1996.
31. Journal of Nepal Geological Society, Vol. 13, 1996
32. Journal of Nepal Geological Society (Abstract Volume of First Nepal Geological Congress, 1995), Vol. 12 (Special Issue), 1995.
33. Journal of Nepal Geological Society (Proceedings of 9th Himalaya–Karakoram–Tibet Workshop, 1994), Vol. 11 (Special Issue), 1995.
34. Journal of Nepal Geological Society, Vol. 10, 199531. Journal of Nepal Geological Society (Abstracts of 9th Himalaya– Karakoram–Tibet Workshop, 1994), Vol. 10 (Special Issue), 1994.
35 . Journal of Nepal Geological Society, Vol. 9, 1993.
36. Journal of Nepal Geological Society, Vol. 8, 1992.
37. Journal of Nepal Geological Society, Vol. 7, 1991.
38. Journal of Nepal Geological Society, Vol. 7 (Special Issue), 1991.
39. Journal of Nepal Geological Society, Vol. 6, 1989.
40. Journal of Nepal Geological Society, Vol. 5, No. 1, 1988.
41. Journal of Nepal Geological Society, Vol. 4 No. 1 & 2, 1987
42. Journal of Nepal Geological Society, Vol. 4 (Special Issue), 1984*
43. Journal of Nepal Geological Society, Vol. 3, No 1 & 2, 1985
44. Journal of Nepal Geological Society, Vol. 2 No. 2, 1985
45 . Journal of Nepal Geological Society, Vol. 2 (Special Issue), 1982*
46. Journal of Nepal Geological Society, Vol. 2, No. 1, 1981
47. Journals of Nepal Geological Society, Vol. 1, No. 2, 1981*
48. Journal of Nepal Geological Society, Vol. 1, No. 1, 1981*

*Out of prints (only photocopy available upon request.)

NEPAL GEOLOGICAL SOCIETY
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September 2011 – August 2013

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EDITORIAL

The Bulletin of the Nepal Geological Society brings out activities of the Nepal Geological Society and its members in the preceding year. This is the 29th volume of the Bulletin and contains news about scientific talk prgrammes, scientific articles presented in the talk programmes, report on the last Annual General Body Meeting, news about outstanding achievements by the member of NGS within the last one year, and obituary on the members who have passed away. The bulletin also contains a number of popular articles in the field of geology which are of the public concern. We believe that these information and articles will be of great interest to the geo-scientific community and general public interested in geo-science. A number of books were published by the members of the NGS last year in the field of geo-science. The Bulletin also gives a brief synopsis of the books.

The editorial board would like to extend its sincere thanks to all the authors for contributing their papers to this issue. Those papers have increased the importance of this Bulletin. We would like to express our sincere thanks to the 15th executive committee of the NGS for providing necessary information for the Bulletin. On behalf of the 15th executive committee, the editorial board extends its acknowledgements to various consulting firms and governmental/non-governmental organizations for their technical and financial support to the society.

We hope that the readers will find this volume useful and informative. Comments and suggestions for further improvement of the bulletin are always welcome. We hope to receive your continued support and cooperation in future.

- Editorial Board

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भूकम्पीय सुरक्षाका लागि

घुँडा टेकी, गुडुल्की, ओत लागी समात !
Duck, Cover and Hold on

गुडुल्किनु (Duck)	ओत लाग्नु (Cover)	ओतलाई समात्नु (Hold on)
गुँडुल्किनु (Duck) भनेको घुँडा टेकेर घोप्टो परी, गुडुल्किएर हाँसले भ्याँ टाउको लुकाउँदै आफ्नो शरीरको आयतनलाई सकभर सानो बनाउनु हो ।	घोप्टिएर घुँडा टेकी बस्दा टाउको र मेरुदण्ड जोगाउन कुनै टेबल जस्तो बलियो सामग्रीको ओत लागी उष्ठिटिएर आएका वा खसेका वस्तुहरुबाट बच्नु हो ।	भुईंचालोको बेला ओत दिने वस्तु वा आफु नै हल्लिनुबाट जोगिन ओतलाई बलियो गरी समात्नु हो ।

विद्यालयमा "Duck, Cover & Hold on" को अभ्यास गर्ने प्रक्रिया

क. संकेत - १ विद्यालयमा तोकिएको व्यक्तिले एक मिनेट सम्म घण्टी बजाउने

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ग. संकेत - २ पुनः शिक्षकले २ घण्टी बजाउने । त्यसपछि पहिले नै पहिचान गरिएको सुरक्षित स्थान तर्फ नहड्बडाइकन लाईन लगाएर जाने (चित्र ख) ।

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चित्र क - घुँडा टेकेर घोप्टिई, गुडुल्किएर टाउको जोगाउँदै

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चित्र ग - प्राथमिक उपचार गरिँदै

यही प्रकृयालाई अन्य संस्थाहरूमा समेत प्रयोग गर्न सकिन्छ ।

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यो सामग्री अमेरिकी सहायता नियोग USAID को आर्थिक सहयोगमा भूकम्प प्रविधि राष्ट्रिय समाज-नेपाल (NSET) द्वारा सञ्चालित "भूकम्पीय जोखिम व्यवस्थापनमा सार्वजनिक-निजि साझेदारी प्रवर्द्धन कार्यक्रम (3PERM)" अन्तर्गत प्रकाशित गरिएको हो ।

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